Official Proceedings

OF THE

Western Railway Club

FOR THE

Club Year 1911-1912

The Club meets the third Tuesday of each month, except June, July and August. The Club Year ends with the meeting in May.

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OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was held at the Auditorium Hotel, Tuesday evening, September 19, 1911.

Second Vice-President Henry LaRue in the chair.

The meeting was called to order at 8:00 P. M.

The following members registered:

Alexander, W.
Anderson, Wm.
Ayers, A. R.
Barber, F. L.
Barnes, C. A.
Barnum, M. K.
Bason, F. M.
Bourne, G. L.
Bjurstrom, G. A.
Bloom, E. B.
Brubaker, W. C.
Buckingham, C. L.
Cooke, W. J.
Covert, M. F.
Crawford, J. G.
Dalman, J. W.
DeVoy, Jas. F.
Doran, H. G.
Downing, I. S.
Ensign, H. W.
Framer, R. E.
Friday, C. B.
Fromm, A. B.
Gale, W. T.
Gardner, H. W.
Gibbs, E. L.
Gilbert, H. H.
Goddard, J. S.
Goodwin, G. S.
Graves, F. W.
Green, Herbert
Guilford, A. L.
Gunn, F. M.
Gerzberg, W. F.
Hall, W. B.
Hunter, Percival
Jenks, C. D.
Jones, L. E.
Laird, E. C.
Lammedee, J. M.
LaRue, H.
Lovell, C. P.
Lucas, A. N.
Lundehn, Otto
MacPherson, A. F.
Manchester, A. E.
Martin, P. A.
McClain, H. O.
McGinnis, C. P.
Miller, Wm.
Mills, E. S.
Michael, L. P.
Morey, E. H.
Motherwell, J. W.
Monroe, M. S.
Nathan, C. A.
Neely, B. J.
Olmstead, C. J.
Otley, B. J.
Park, P.
Putnam, W. F.
Rayburn, E. R.
Schlacks, W. J.
Schroyer, C. A.
Scofield, W. C.
Seley, C. A.
Sharp, W. E.
Sheafe, J. S.
Slater, F.
Silk, E. E.
Sommers, J. F., Jr.
Sommers, J. F., Sr.
Springer, F. C.
Struble, C. H.
Sweringen, F. H.
Tawse, W. G.
Taylor, J. W.
Thurnauer, G.
Tinker, J. H.
Walsh, W. J.
Webb, E. W.
Willcoxson, W. G.
Winn, C. F.
Woods, A. C.
Worth, W.
Wymer, C. J.
Van Doren, W. T.

The Chairman: Gentlemen, please come to order. The first order of business is the reading and approval of the minutes of the last meeting. They have been printed and distributed, and hearing no objections we will take it for granted they will be approved as printed. Hearing no objections, they will stand.

The next order of business is the Secretary's report.

The Secretary: Mr. Chairman, I have the usual membership statement:

NEW MEMBERS.

Name	Occupation	Address	Proposed by
W. A. Summerhays,	G. S. K. Ill. Central R. R.,	Chicago	J. S. Sheafe
Mac K. Kimberly,	T. H. Symington Co.,	Chicago	C. R. Naylor
C. G. Tarkington,	Westinghouse E. & M. Co.,	Chicago	G. P. Nichols
H. K. Trask,	American Loco. Co.,	Chicago	A. M. Sheffer
C. E. Miller,	Safety Car Heating & L. Co.,	Chicago	J. G. Van Winkle
J. H. Rodger,	Safety Car Heating & L. Co.,	Chicago	J. G. Van Winkle
L. B. Morehead,	Draftsman, Ill. Cent. R. R.,	Chicago	H. O. McClain
A. G. Crocker,	Draftsman, C. & N. W. Ry.,	Chicago	L. P. Michael
F. A. Harper,	G. F., Western Steel Car & Fdy. Co.,	Chicago	P. Parker
W. E. Worth,	Gen. Supt., Illinois Tunnel Co.,	Chicago	C. A. Barnes

RESIGNED.

W. J. Lynch	H. B. Hatch	J. J. Adams
H. W. Peters	F. R. Pechin	C. H. Quereau
G. G. Fisher	C. R. Naylor	S. F. Denny
F. W. Marquis	C. H. Johnson	T. F. Brady
Jos. Muhlheisen	E. E. Kretchmer	E. B. Halsey
J. O. Neikirk	G. A. Beland	M. L. Newhall
J. H. Stubbs	J. S. Ford	Sam'l Higgins
C. V. Weston	T. F. Dreyfus	N. F. Harriman
E. R. Webb	S. W. Prime	Geo. W. Moses
Wm. Lalor	A. E. Hooven	A. J. Walsh
W. D. Wood	T. P. Convey	H. S. Bryan
W. S. Taussig	H. L. Holman	W. J. McAndrew
J. T. Carroll	W. P. Evans	

MEMBERSHIP STATEMENT.

Membership, May, 1911		1,502
Resigned	34	
Deaths	4	
Dropped		38
		1,464
New members		10
Total membership		1,474

The Chairman: Gentlemen, the next order of business this evening is the presentation of the paper by Mr. George G. Floyd. The paper was not received in time enough to be printed, and we will now hear from Mr. Floyd.

Mr. Geo. G. Floyd: Mr. Chairman and Gentlemen: I am sorry the paper was not received in time to have it printed, but I did not know in time that I would have to read the paper, until last Friday, and I did not get it done in time to have it printed. I did not get it finished until late this afternoon.

SOME EXPERIMENTS WITH TRUCKS

By Mr. George G. Floyd, Chief Mechanical Engineer, American Steel Foundries

Some seven or eight years ago the Company with which I am connected began to manufacture and put upon the market a "One Piece Cast Steel Truck Side Frame," which at the outset, presented, from the designers as well as the truck builders standpoint, certain features and difficulties peculiar to itself which were somewhat new to the freight car truck building art. There were problems of assembling, dismantling, preservation of standards, etc., which it was *not* possible to solve by turning to and profiting by the well developed art of the almost universally used arch bar truck.

It seemed that the best, simplest and cheapest constrution, considering the truck as a whole, made it necessary to revise the usual method of assembling an arch bar truck. The truck bolsters must be put into place first, instead of almost last, the spring plank or channel going into and being fastened in its final position next after the bolster and before the bolster springs could be put into place. In dismantling the truck for any reason, the reverse operation is to remove springs—then the spring plank, before the bolster can be taken out.

This enforced procedure immediately brought forward an important point—the connection or fastening between the spring channel and the side frame. Should it be a gibbed, a pin and socket, dove tailed, or some other such connection, depending upon the weight of the car and friction to hold the channel down and in place? Should bolts be used, or should it be a well-riveted joint? Each of these plans had certain merits as well as certain defects, and as each respective plan was favored by different ones of our railway customers to the exclusion of the other two all three plans were tried out in service.

The diversity of opinion hinged upon the point: was it more important to be able to assemble and dismantle the truck with ease, despatch and little expense, or was the joint or connection between the spring channel and side frame the most important part of the construction to be considered?

It is interesting to note the arguments for and against the three available methods of construction.

The first one suggested was that of a frictional connection, with some method of construction, so that the spring channel could merely

be dropped into place and be held in position by the weight of the car on the bolster springs, and without the direct aid of bolts or rivets. The advocates of this plan presupposed that it would be frequently necessary, comparatively speaking, to dismantle the truck so as to exchange truck bolsters, and that it should be possible to make this exchange without the necessity of removing bolts which might not be replaced with the original security, owing to the probability of the bolts, nuts and nut locks being broken, lost, destroyed or becoming ineffective in re-assembling, because of disturbing the original application of the bolts. Much less should a riveted connection be considered, as this involved more or less expense and time in cutting and withdrawing the rivets and the furnishing of new ones in remaking the joint. It was admitted that with this type of construction it was possible that the truck would not be held square for any great length of time in service. The critics of this plan contended that, without going to the expense of a machined, gibbed or dove-tailed connection, it would be impossible to make a joint that would not have a certain amount of initial movement, and that any initial movement or play would promptly increase in service to such an extent that the joint would soon be useless as a means for holding the truck square or the side frames parallel. The friends of this construction answered this criticism by replying that it was not essentially necessary that the truck be held square; that it had never been proven that there was any merit in having a square truck, and that in their opinion the advantages of a truck held square were greatly overestimated, and that the matter of repairs and renewals was of more importance. The whole scheme of construction in all its details was viewed by those favorable to this plan, from the repair track standpoint, their preference being decidedly in favor of what might be termed a "loose" joint between the spring channel and the side frame. There were also some in favor of this type of spring channel connection, not because they thought it would be necessary to often remove the channel, but because they believed that a truck held square was not the correct principle; advancing the argument that it was the better plan to have a loose connection, so the truck could by weaving in and out of square adapt itself more readily to track conditions, and take curves with the least strain on the side frame, and with less friction between the wheel and the rail. Those in favor of a bolted and riveted spring channel and frame connection agreed in general as to the principles of truck construction, believing that while it might be necessary to dismantle the truck during its life, this was not an important point to be considered; because of the uncertainty as to how many times the truck would have to be taken apart and the doubt as to whether it would ever have to be dismantled. It was thought not a good business or engineering expedient to sacrifice any part of the mechanical construction. in order to provide for something that might not happen at all, or, if

it did happen, might not happen often and then would not be a serious happening comparatively. As to providing for easy repairs, it was contended that the truck which was so mechanically constructed that it was the easiest to repair, when it got out of repair, was likely to get out of repair easier, and more frequently than the truck that was built with the view of its not getting out of repair.

Many considered it of prime importance to have a rigid or tight connection between the spring channel and the side frame, so that the truck would be held square and prevent any parallel moving of the side frames, one ahead of the other, when the truck was rounding a curve; while those favoring a square running truck, and one built with a view of its staying in repair, agreed as to the principles of truck construction, they differed on the detail as to whether to use bolts or rivets in the spring channel. Some thought bolts, if properly put in, were good enough and they were also willing to make a concession to the repair track and use bolts instead of rivets. Others took the position that bolts would not remain tight, and that they would only defeat the very purpose for which they were intended, and that by far the best construction was a tight riveted joint.

As indicated at the beginning, these various plans were all tried out in service. It did not take long for it to develop that bolts were of no value if a tight joint was expected, and they were promptly eliminated from consideration.

Regarding the point raised that it was necessary to have a loose connection between the spring channel and the frame, because of the possible frequent necessity of replacing the truck bolster on account of failure, it was found that the American Steel Foundries and the Simplex Railway Appliance Company had records dating back some ten to twelve years, that if checked over and tabulated would show the number of truck bolsters they had been called upon to replace, as well as the total number furnished. As practically all bolsters had been furnished under a guarantee, it was presumed the railways had taken advantage of the guarantee and asked a replacement for all failures.

It was decided to have the records checked, which check showed that the two companies had sold in 15 years, in round figures, 1,700,000 truck bolsters that had seen a guaranteed service averaging somewhat over five years. During this time the requested replacement had been approximately one-tenth of one per cent—one bolster on 500 cars in five years. It was found by those in favor of the riveted connection that the rivets could be cut, the spring channel removed, then replaced and riveted for a cost in the neighborhood of $3.50. For the sake of argument, this cost was set down as $5.00. Using this amount as the cost of exchanging the truck bolster, and using the number of times this exchange would have

to be made as indicated by the records of the two companies mentioned, gives a cost of $5.00 in five years on 500 cars, or two-tenths of one cent per car per year. This takes no account, of course, of the number of times the exchange might have to be made for causes other than the failure of a guaranteed bolster, such as a fire, wreck, or serious derailment. If these causes doubled the cost and the doubled cost is again multiplied by ten, the cost of dismantling and re-assembling the riveted joint would be less than five cents per car per year, a cost so insignificant that the question of a design, or a construction merely for the purpose of an easy exchange of a truck bolster was eliminated. This then narrowed the question of design down to two points—a loose truck for the sake of a loose truck, or a square truck for the sake of a square truck.

As the truck we are manufacturing could be built either way, we, therefore, were in a position to satisfy those of our customers who wanted a loose truck, as well as those that thought the square truck the best. It might quite naturally be supposed that it would make little difference to us which type of truck the customer chose to use. We, no doubt, could have assumed a neutral position without being charged with taking too little interest on one side or the other.

We did not elect to take the middle position, however. It was evident that if the loose truck was the correct one, the square truck could not be right, and if the square truck was the most practical one, the loose truck could not at the same time be the most scientific. They could not both be right in theory, because they were so unlike in principle.

We decided upon an investigation on our own account, and the investigation was started along three lines:

First, the published information and literature bearing upon the subject was looked up.

Second, we interviewed and sought advice and information from various railway engineers, whom we thought were in a position to throw light on the question.

Third, we began an investigation on our own account, along the lines of several roads, directly into the service performance of various types of trucks.

The railroad literature gave us next to nothing in the way of information. There seemed to have been no experiments or tests made along the lines we were investigating—at least so far as we could find.

The railway men consulted were so at variance in their opinions and presented so little tangible and reliable data from which a deduction could be made, that this source of information was more or less disappointing.

Our direct examination of the performance of trucks in every day service was somewhat more fruitful of results, but the data

gathered, while interesting and instructing, were not entirely conclusive.

The column of facts we were able to set up pointed strongly to the square truck as being the most scientific construction, but to just what degree it was the better truck was not determined.

The fact was also developed by our investigation that the ordinary arch bar type of truck was undoubtedly a loose truck and owing to the very nature of its construction, could not be anything else but a loose truck.

As the truck we were making could be built as a square truck just as well as a loose truck, it was apparent to us that our truck, along with the many other advantages claimed for it over the arch bar truck, possessed in particular one advantage—that of squareness—against which it would be difficult for the arch bar truck to compete, provided it could be determined that the apparent advantages of the square truck were of any real material value.

After holding the matter under consideration for some time and after consulting some of our railroad friends it was decided by the officers of our company that in view of the possible ultimate merits of the square truck and in view of the evident poverty of information on the subject, to build a piece of full size track, install all the scientific apparatus necessary, and determine beyond doubt, if possible, if the square truck was the better construction and how much, or to what degree, it was the better.

One of the first questions that came up for decision was whether it would be better to build the experimental track so that a complete car could be used on it, or to build it with the view of testing a single truck only, separate from the car body. It was decided to arrange for the single truck only. We had in mind only the one thing—that of determining the flange and rolling friction as influenced by the truck getting out of square.

In using complete cars there would be introduced so many other factors and complications that it would be practically impossible to separate out the friction due to any one factor alone. With a car there would have entered into the result the friction of the center plates and side bearings, the spacing and clearance of the side bearings, the center of gravity of the car, its length and various other things that it would be impossible to measure, or even estimate, what per cent of the whole result should be charged to each individual factor.

By using single trucks all other factors would be eliminated, except the one difference of truck construction.

In order that the test would be made correctly, and in accordance with scientific methods and by one without prejudice on one side or the other, the services of Prof. Louis E. Endsley were secured. Mr. Endsley is Associate Professor of Railway Mechanical Engineering at Purdue University.

Professor Endsley superintended the completion of the track, installed the scientific apparatus and with the assistance of two other engineers he brought from the University, had entire charge of the testing plant and the tests. The testing extended over a period of nearly four months during the summer of 1910. A full report of the summer's work was published the following January. No doubt most of you have copies of the report.

The report is in the nature of a mere statement, or a tabulation of the tests run—an unvarnished record without embellishment.

There were many things developed in the tests in the way of incidentals—sidelights, I might say—apart from the main tests, that are not fully set forth in the published report. It is my purpose to discuss some of these incidentals.

After our investigation of the square and loose truck in service and before the testing plant was built, we had formed certain conclusions as the result of the investigation, as well as some opinions based upon the statements, experience and judgment of several railway engineers. While these conclusions and opinions had to be revised somewhat after the tests were run, our conclusions were in the main correct as to theory and as to what the results might be, and had to be revised only because the material effects had been somewhat underestimated.

For instance, it did not take long to discover that trucks in service did get out of square; that is, in rounding a curve the side frame on the inside of the curve would move ahead of the frame on the outside of the curve. Just how much was a matter of doubt, or I might say, a matter of calculation, rather than of actual measurement. The greatest amount that any one suggested was one and one-quarter inch. We were hardly prepared to find that it was nearly as much as three inches.

We had expected to find that there might be ten to fifteen per cent difference between the curve friction of loose and square trucks. We found as much as one hundred and fifty per cent between the best square truck and the worst loose truck. We had anticipated that the load on the truck and its speed would regulate the amount the truck would go out of square, but it would seem from the tests made that the truck would go out of square approximately the same amount every trip around the curve regardless of its weight and speed. In fact, when it was merely pushed around the curve, slowly by hand, it would go out of square, the same amount as when it went around at high speed.

It was evident—as each truck tested went out of square an amount peculiar to itself—that there was something about its construction that acted as a stop to prevent further movement. Probably a wedging of the axle against the opening in the back end of the box and against the wedge and brass. It was noted in that type of arch bar truck in which the columns were riveted securely

to the channel, that the truck went out of square a less amount than those trucks in which the columns were bolted to the channel. This riveting of the column to the flanges of the channel made one less loose joint, and it may be that this one less loose joint introduced a stop at the columns, or column bolts, which brought the truck to a bearing in advance of the stop furnished by the journal and box.

There was also found an indication that the older a truck was in service, the more it would go out of square, this being no doubt, due to a wearing away of the parts that stopped further movement of the truck, as well as a gradual loosening of the parts tending to hold the truck in square.

An interesting experiment was made to determine what effect the time of service would have upon those parts of an arch bar truck that are supposed to hold the truck square.

A car was accidentally found in the yard that had been out from the contract shops less than a month. It was a 50 ton truck of heavy construction, had cast steel truck columns, bolted to a heavy channel, with two long bolts reaching through both columns. These bolts were tight as were all bolts about the truck. The truck was put upon the testing plant and showed a very good test, one side frame moving ahead of the other only ¾ in., while a duplicate of this truck in service one year showed a movement of a trifle over one and one-quarter inch, and a duplicate in service eight years showed almost two-inch movement. When trucks are new, all the surfaces bolted together being rough and the bolts tight, the friction between the parts will prevent all but a slight movement. It is this small initial movement of parts that brings about the final general looseness of the whole construction. The high points of the rough joint wear away, allowing the bolts to become loose, and then there is a still greater loosening of the parts in general by abrading, polishing or wearing away of the parts by friction. A bolted joint of this character is probably successful only when it is possible to so design it that all initial movement will be prevented.

It only takes a small movement of the spring channel to give a considerable motion to the side frames, one ahead of the other. One-sixteenth of an inch motion of the channel under the spring seat will allow the side frame at the opposite side of the truck to move forward or backward about ¾″ to ⅞″.

That this initial motion exists in an arch bar truck, even when new, is not surprising when it is considered that the holes through the upturned flange of the spring channel for the horizontal column bolts are drilled 1/16″ larger than the bolt, the holes in the arch bars are drilled 1/16″ larger than the column bolts, and the hole through the column is cored usually ⅛″ larger than the bolt passing through it, a possible 3/16″ to 5/16″ looseness to start with in the fit of the bolts. One does not have to look far to find reasons why the arch bar truck is a loose truck.

The fact that the arch bar truck does get out of square on a curve, the movement increasing with the age of the truck as indicated in the tests made by Professor Endsley, probably accounts for the trouble and expense for the upkeep of columns, column bolts, spring plank, bolts, etc. There is a continual motion and straining of parts at this point. It is impossible to keep the bolts tight, great trouble to keep them even in place, and it is quite natural that the repair account should be heavy if the joint is to be kept up, and it is quite natural, if the joint is not kept in proper repair, that the truck should fail to give the expected service results.

In reference to the connection between the spring channel and one-piece cast steel side frame, the tests demonstrated that a bolted connection was of little or no value as a means for making a tight immovable joint, that would hold the truck in square. The bolts were invariably found loose, and even after being tightened up thoroughly just before running a test, a very few runs would soon loosen up the joint. An extended examination of cars in service indicated that the bolted connection was of little value, as the bolts were nearly always found loose. On the other hand, an investigation covering a period of almost two years, and including several thousand cars, showed that the riveted joint was developing no signs of looseness, and was performing well the duty for which it was designed. An occasional loose rivet was found, but one or even two loose rivets in a joint composed of a total of eight would indicate a looseness due to an imperfect application of the one or two rivets, rather than a looseness caused by service. The nature of the joint is such that road service could not loosen one or two rivets without loosening the whole joint. It was taken for granted that tight rivets presupposed a tight joint, and a tight joint meant a square truck. (It has been found, however, that tender trucks require more rivets than car trucks.) The Granite City tests confirmed the presumption that the riveted connection between the spring channel and side frame was a tight connection, which would remain tight in service and would hold the truck in square. Several of such trucks in service were tested and while the registering apparatus indicated a small movement it was not sufficient to influence the flange friction because the indicated movement was largely a changing in the perpendicular of the top of the side frame, due to the rigid connection between the two side frames being located some 12″ to 15″ below the top of the journal boxes, where the load is delivered to the axles. There was also a small amount of twisting of the side frame lengthwise along a line connecting the top of the two oil boxes on the same side of the truck, that was registered, as if it was a movement of the truck in and out of square. This same movement—in about double the amount—was also noted on the one or two arch bar trucks tested that were so new in service that they remained practically in square during the tests because the spring channel connection had not worked loose to any extent.

Professor Endsley's report shows that there is quite a material difference in curve friction in favor of a square truck, as against a loose truck. An amount of difference sufficient to affect the coal pile, life of the rail, wheel maintenance and train resistance.

It seems somewhat remarkable, considering the age of railroads in this country, that such a test was made only last year, evidently for the first time.

Reducing the results obtained on the test track to a five and one-half degree curve brings out some interesting and somewhat startling information. A five and one-half degree curve is selected because it is possibly an average curve, and also because it makes a division by an even divisor. The small fractions are left out, in order to make round numbers.

The draw bar pull in pounds per ton is found to be 9½ lbs. for the best square truck; 13.7 lbs. for the worst square truck; 11 lbs. for the best loose truck, and 17 lbs. for the worst loose truck.

Broadly speaking, the difference between the square and the loose truck is due to a difference in truck construction.

The difference between the best and the worst square truck is due almost entirely to wheel condition. In tabulating the results, as a matter of convenience, all trucks that went out of square one-half inch or less were classed as square trucks; so the difference in friction between a truck absolutely square and one out of square one-half inch should be deducted from the total difference between the best and the worst square truck—the balance is chargeable to wheel condition. However, the difference between a truck square and one out one-half inch is a small amount. This fine line was not conclusively drawn in the tests, because of lack of time. This was reserved as one of the refinements to be run down in this year's tests.

The difference between the best and the worst loose truck is probably more evenly divided between that coming from truck construction and that resulting from wheel condition.

The difference between the best square and the best loose truck is favorable to the square truck by 15.8%—and as between the worst square and the worst loose 24% in favor of the square truck. In both cases the difference may be said to be difference in truck construction. As between the best and the worst square truck, the difference is 44%, largely wheel condition. Between the best and the worst loose truck, there is a difference of 54%. Possibly somewhere near evenly divided between truck construction and wheel condition. Between the best square truck and the worst loose truck is 79%. The difference between the worst loose truck when run as a loose truck, and the same truck squared and run as a square truck, was somewhere near 40% in favor of the truck squared. This difference being entirely due to truck construction.

The figures just given are from specific tests of specific trucks, and it is probably hardly correct to undertake to construct a series of averages from them when it is considered that the averages used in calculating train resistance for actual service must of necessity represent the average resistance of all trucks, as they come in service. Therefore, it might be well to state that the average difference between all the square trucks and all the loose trucks tested was approximately 24% in favor of the square truck, based on a five and one-half degree curve.

An average is the mean between two extremes. If the maximum and the minimum are near and close to the average, there is small chance to close up the gap between the average and the maximum in an attempt to reduce the average. But, if the maximum, and the minimum are comparatively widely separated, and the units in between are valuable, there is a greater chance to reduce the average and an effort is worth while. It is probable that little is known of the actual maximum and minimum that make up the average train resistance as used in every day practice.

It would seem that some information has been developed along this line by the test made last summer, and the figures quoted above are possibly most interesting from this point of view.

The tests show there is a difference of almost 80% between the maximum and minimum, due to both truck construction and wheel conditions and approximately 40% due to truck construction alone. A difference certainly—sufficiently material—to justify an elaborate and serious investigation by the railroads.

Several railroad men who visited the plant during the tests were forcibly struck with the idea that it was possible car wheels were allowed to run too long, and it might be better economy to remove them sooner.

When the theory and reasons are known, it is not surprising that the curve friction of a loose truck should be greater than a square truck. Some very interesting experiments were made by whitewashing the rails on the curve, and noting the difference in contact between the wheel and the rail with the truck square and loose.

When a truck was run square, there was only one point of contact between the wheel and the rail. This was on the ball of rail and in the deep part of the throat of the flange of the wheel. When the truck was run loose, there were two distinct points of contact, one on top of the rail and one on the side of the rail, there being from 1/8″ to 3/8″ between these two lines, depending upon how much the truck went out of square.

In this case the whitewash was left on the ball of the rail, and the throat of the wheel did not show any contact with the ball of the rail. When the truck was stopped on the whitewash and run back, the end of the mark on the side of the rail made by the flange was from 1″ to 2½″ in advance of the end of the mark on top of the rail, made by the tread of the wheel.

It could be seen, when the truck was in this position, by sighting along the edge of the rail, that there was no contact between the throat of the flange and the ball of the rail.

When the square truck was rounding the curve, the throat of the wheel being in contact with the ball of the rail, and the axles square with the track, the outside wheel would climb up on the rail, enlarge itself an amount sufficient to make up for the difference in the length of the inside and outside rails, and the wheels would go around the curve without slipping—the friction being all rolling friction. But when the truck was running as a loose truck and got out of square, the throat was not in contact with the ball of the rail, and the flange being in contact with the side of the rail, acted as a shoulder so that the wheel could not move over on to the throat and climb the rail. Therefore, either the outside or the inside wheel had to slip the difference between the length of the two rails.

When the truck is running square the friction between the wheel and rail is rolling friction. But when the truck is running loose and gets out of square, there is just as much rolling friction as there was before and in addition there is the sliding friction between the flange and the side of the rail, which must be considerable, and the slipping or sliding of the tread of the wheel, on the top of the rail—because of the difference in the length of rails, and the inability of the outside wheel to enlarge itself, owing to lack of throat contact with the ball of the rail.

This was plainly noticeable by listening to the noise the truck made in going around the curve. When the truck was square, it made just a single rumbling noise quite natural to a vehicle of this kind, but when running loose, in addition to the ordinary rumbling noise could be heard a loud flange song, and a distinct high sounding and piercing noise caused by the tread slipping on top of the rail. This latter noise was not a continuous one, but an intermittent noise, with very short intervals. The flange song was a continuous noise.

On a five and one-half degree curve, in the distance a 33″ wheel makes in one revolution the outside rail is about ½″ longer than the inside rail, and with a loose truck this means that either the outside or the inside wheels must slip this ½″ every revolution. and if the outside wheels do the slipping, they not only have to overcome the friction between the tread and top of rail, but also the friction between the flange and the side of rail. It is possible that the inside wheel does most of the slipping.

There is also one other source of increased friction in the loose truck, which is a sliding friction. When a truck is running out of square, the axles are not square with the track: therefore, the wheels are not revolving in a plane parallel with the direction of the rails, and if it were not for the flanges, the tendency of the wheels would be to run to the right, or the left, as the case might be. The natural

track for the wheels to make would be one diverging from the rails, and they would only track in a line with the rails by a certain amount of slipping. This point can better be illustrated perhaps by presuming the front wheels of a wagon turned the necessary amount to go around a street corner, and then locked in this position. One can readily see it would require an extra effort on the part of the horses to pull the wagon, with the front wheels so turned and locked, in a straight line. The front wheels would revolve, but much slower than the rear wheels, and they would also slip along the pavement.

It must be this slipping that causes the increased friction in loose trucks going out of square from nothing up to one inch, and before the flange begins to make a contact with the side of the rail. It will be noticed from Professor Endsley's report, that there is a big jump in the friction between an inch, and an inch and one-half out of square. It is thought that the increase in friction up to one inch out of square is caused by the gradual increase in the slipping action just noted above, and that along about this point is where the flange begins to make the sliding contact against the side of the rail.

This is another very nice point that will be developed in this summer's tests.

Of course, it might be said that these tests, as they deal almost entirely with curve friction, do not interest the road that has almost all of its mileage straight track. This would be taking a somewhat narrow view of the matter. Owing to the great exchange or interchange of cars between the different railroads, it is possible the man on a road full of curves would be very much interested in the kind of a truck his straight track neighbor puts under his cars.

The tests were made for the sole purpose of determining, if possible, the facts regarding the difference between trucks that run square and those that run loose, as there seems to be a great difference of honest opinion among railroad men, regarding the merits of each type of truck with apparently no convincing data at hand on which a final judgment could be based.

The tests were made in the only manner in which it was possible to make them, considering the particular facts it was desired to determine. The results of the tests and experiments were given out because, first, they are tests that have never before been made so far as is known, and second, the data secured were considered of such value and importance that they would be at least passively appreciated by the railroad official who is interested in the economics of railway operation, and, third, because the majority of railroad men who knew the tests were being made requested that they be furnished with full results.

It is not the idea that these tests are final, nor that they represent absolutely service conditions. They were given out merely for

what they are worth, and in so far as they go. They are considered as a preliminary to a more serious test that it is hoped will be made by the railroads themselves. It is felt, however, that the tests are a close approximate to what will be found in actual service, and are of sufficient value to be entitled to full consideration, pending more elaborate dynamometer tests in actual service.

These tests were run upon a curve somewhat sharper than is found in ordinary main line track, with the idea that differences would be more easily measured. After the season's work was finished and the results tabulated, it was decided to continue the work again this summer, with the view of determining, if possible, several things that could not be determined with a single curve. There was also much work planned that could not be finished last year. It was desired to carry on a somewhat different line of experiments, for which several curves seemed a necessity, therefore, the test track was entirely rebuilt—a 3 degree, a 6 degree and a 12 degree curve added. The 3 degree and the 6 degree curves being laid with both new and old rails side by side. An arrangement having been made with the Missouri Pacific Ry. allowing the old rails to be taken right out of service on main line 3 degree and 6 degree curves.

This summer's work is not yet finished. It is expected the plant will be in operation until cold weather stops operations. It is also likely that all the work laid out for the summer will not be finished. One experiment leads to another, and it would seem that this line of experiments could be carried on for several years without exhausting the subject. The results of the experiments so far made this summer have not yet been tabulated, but so soon as the plant is closed for the season, a full report will be published and distributed to those who are interested in this line of investigation.

The Chairman: Gentlemen, you have listened to this well-written paper on the subject of "Some Experiments with Trucks." This paper is now before you for discussion. It seems a singular coincidence that I am called upon to preside for the first time over the first fall meeting of this Club. I will not attempt to do the same as some of my predecessors,—threaten the members on the floor for not talking. I know there are quite a number of gentlemen here who have a few ideas about trucks, and I sincerely hope that at this first meeting at which I have had the honor to preside that my main duties will be to preserve order, and see that no more than two or three talk at once (laughter). Gentlemen, I will not call on you by name for quite a while.

Mr. C. A. Schroyer (C. & N. W. Ry.): Gentlemen, I don't feel as though I am able to say very much in regard to the paper that has been read here to-night. It is one of the most instructive papers, as regards the construction of a truck, that I have ever read or ever listened to. I read the former report. What I have heard to-night

has turned me around completely as regards my ideas of the conditions existing in the truck under the car when it is rounding a curve and going from the curve on to a tangent. I have always had the impression that the position of the truck underneath the car body was such that the flanges of the wheel maintained a line parallel with the rails. The information obtained in this test shows that they do not; that the side of the truck nearest the center of the car moves forward. If that is the case, the question in my mind is as to whether we are not wrong in depending solely upon the head of the outside rail for curving the truck underneath the body of the car. We know if that truck maintains the position underneath the body of the car that it should on the curve, that the flanges of the wheels will be parallel with the rails, and to get them parallel with the rails it is necessary that the side of the truck on the long side of the curve must move forward when it enters the curve, and vice versa when it enters the tangent from the curve. If that is the case, the question in my mind is as to whether these tests should not be extended to determine whether, on our shorter curves on main line tracks, it would not be an advisable thing to put a guard-rail on the inside of the inside rail, for the purpose of swiveling the truck underneath the body and having it assume the proper position in rounding the curve to prevent the wearing away of the outside railhead which we know it is doing, and which I can understand from the fact that the inside of the truck moves ahead of the outside of the truck on the curve. I have known of a railroad company in this country building a truck that had absolutely nothing to hold it square except the truck bolster, and the amount of motion between the guides on the bolster and the columns on the truck—in fact there was no column on the truck—would allow the axles to be drawn out of the square line, at least two inches and a half, standing right on the tangent; to block the wheels on one side and pinch the wheels on the other two inches and a half; and yet those trucks ran for years. But I want to state to you it is like a good many other things on the railroad: there was a loss of power, and nobody was ever able to measure that loss of power; it was a small loss on one pair of wheels or one car, but it was multiplied by the number of cars they had in service, and yet no one was able to determine what it represented. We have a thousand and one things on our railroads to-day that are just in that condition. I want to tell you, however, that the strenuous conditions confronting us to-day are going to force us to find out what these things are, and we must use the things that will give us the best results; whether the difference between the results we are obtaining with the poorest thing and the best is so small we cannot measure, or whether it is not.

I am sorry we haven't had this paper before us so that we could read, study and reflect on it and have a chance to come up here and discuss it more intelligently than we can from the reading we have

heard. I can't recall all the good points that I have heard in that paper, and for that reason I am not able to discuss it in as intelligent a manner as I would like to, but before the meeting is closed I want to make a motion that the discussion on this paper be continued, that we may have a chance to discuss it more fully after it has been printed and put in our hands.

Mr. M. K. Barnum (Ill. Central Ry.): Mr. Chairman, I am reminded by Mr. Schroyer's remarks of a little nephew who had for a Christmas present a small electric motor. It ran for an hour or two and finally gave out, and he resorted to a popular book on electricity that was also one of his Christmas presents. His father saw him tinkering away with the motor and watched him with a good deal of interest, and finally he looked up and said: "Papa, I have found out what is the matter with the motor." And he said: "What is it, son?" "Why," he says, "the book says that you want to connect the positive pole and the negative pole and vice versa, and it has broke its vice versa."

There are a good many different theories advanced on the question of the use of the square truck, and the figures which have been so ably presented in the paper seem very convincing. I agree with Mr. Schroyer that it is rather difficult to do them justice without having had an opportunity to study them more carefully. But the American Steel Foundries, who have conducted these experiments, are certainly entitled to the thanks of all railroad men for the trouble and expense incurred, and they have started an investigation which will be of great value, and which has already contributed very much to the knowledge of the action of wheels and trucks when rolling over the rails.

These experiments seem very convincing in favor of the square truck. It has only been a question in my mind as to just how far the action of the car body on the truck would modify the results obtained from the truck moving by itself. We all know that in running over the railroad a car body sways from side to side, due to the irregularities of the track, the curves, the changes in speed and so forth, and that must necessarily have some influence on the action of the truck on the rail. It will be very interesting to follow the tests which will eventually be made, without doubt, of the trucks under cars, and cars under load, in actual service.

The Chairman: I would like to hear from any others. I don't believe we have all got as short a memory as Mr. Schroyer, to forget all the good points.

Mr. Schroyer: I didn't say I was short of memory, but I meant to infer that there was so much in that paper to digest that I could not do it from one reading.

Mr. A. E. Manchester (C., M. & St. P. Ry.): Mr. Chairman, I was interested in the paper and also interested in reading Professor Endsley's report of last year's work. There are many things

that are exceedingly interesting both in the paper and the report. I am not at all clear, after listening to the paper and after reviewing the report, as to what has been determined that is really of benefit to the railroads, although I am glad the tests have been made and I hope they will continue, and undoubtedly some good will come of them.

It seems to me there is but one sure way of determining what influence the different types of trucks are to have on the rail wear and upon the resistance in hauling trains, and that is by the dynamometer car: that the dynamometer car will give the actual condition that is taking place through the train so far as the pounds that are required to pull the train goes, and that I believe is really the point involved and the point that is undertaken to be proven by the paper,—that the square truck reduces the number of pounds that it will take to haul a ton.

In the earlier years of my railroad life there were a great many more square trucks in service than there are to-day. There is no chance of argument that a square truck is not practical. If we did we would be condemning our engine trucks, which are all square trucks, and condemning all pedestal trucks, which are square trucks. I do recall an experience dating back a great many years ago, of a lot of pedestal trucks that were square trucks, and in order to make them stay on the track we had to cut out the things that kept them square. But still that is not saying very much, because we have still continued to use the engine truck all these years and it stays on the track. I should be very glad to know what would be the result of taking a train of square trucks and a train of loose trucks and testing them under conditions under which we must railroad. I believe it must come in that way before we will ever be well informed as to just what is taking place, and whether there are any of these minute economies referred to by Mr. Schroyer in any of the different transactions that have been referred to.

Mr. Schroyer: If Mr. Manchester is under the impression that this paper is trying to convey to you the idea that the square truck is not a practical truck, why, you are like the Dutchman,—you have got it hind end foremost. I think tests were made on that subject a number of years ago, and if I am not mistaken, they were made on the Illinois Central Railroad by means of a dynamometer car. I think those tests demonstrated very practically or very positively that there was a very decided saving of power, which means a corresponding saving in rail head wear, in wheel flange wear on a 50-car train loaded with coal, some having the square truck, some the flexible truck. But I think that a test of that kind should be made, and while we are so extremely busy on the Northwestern Railroad that we don't have time to do it just now, I hope the Milwaukee Road, which never has very much to do, will find that time (laughter).

The Chairman: We would like to hear from some of the other gentlemen. I am satisfied a large number of them have opinions on this question. I would like to hear from Mr. Sharp.

Mr. W. E. Sharp (Armour Car Lines): Mr. Chairman, I don't believe I could add anything to the discussion here to-night. My position is such that I do not have an opportunity to solve these problems. I have listened to the paper with a great deal of interest. I witnessed the test, I was very much interested in it, but I don't believe I could throw any new light on the subject.

The Chairman: Gentlemen, I don't think you should all consider the question from the drawbar pull. I think both kinds of trucks have been in service long enough to determine, at least in a small measure, the maintenance. I would like to hear from Mr. DeVoy.

Mr. J. F. DeVoy (C., M. & St. P. Ry.): Mr. Chairman, you told me you were going to start trouble. You first said you were not going to do like your predecessors, but I don't know that you have started any trouble in your new way of doing it. What has interested me more than anything else is as to whether you would really get what you wanted out of the crowd. Now after eight years' grappling with these fellows, both in the meeting here and on the road,—and this refers to Charlie Schroyer too,—I want to say to you that you will have to get a gatling gun and a lasso to get some of them up there to do any talking. I have listened to those who have spoken to-night and I don't know now what they mean. None of them have made a statement as to whether they thought a loose truck or a square truck was right. Mr. Schroyer says it is a good paper, and there is not any doubt but that it is in my mind. The boss of the Milwaukee road said he thinks it is a good paper but we would require a dynamometer test. Mr. Schroyer says he has not anything over on the Northwestern Road and that we had better make the dynamometer tests. I suppose it is coming to me that this Club should have a little fun with me, and God knows there is not a man in the country that likes you to have fun with him more than I do. I was not here the last time you assembled, so that you could not get the usual amount of fun that was coming to you. I thought to-night that I had better get over here in the corner with Mr. Seley and maybe it would be some protection, because Seley never does say anything anyway, and he said: "Jim, let them discuss that paper; the less you discuss it the better you are off anyway," and I said: "You don't think they are discussing it now, do you?" (laughter).

Now I have always contended that if a man goes to the trouble and spends his money and his time to write a paper similar to this, that it is up to him to have somebody rake him over the coals a little, and you are not treating him fairly from my code of morals. And if you are not going to do it, why, I am going to ask

him a few questions. There is not any question in my mind but that every statement made in that paper by the American Steel Foundries is correct. I saw the tests. Every one of them was correct. I went home and made a report on it. If my memory serves me correctly, the tests were made on an incline and around a 20 or 22 degree curve. I would like to be corrected on that, because Mr. Floyd knows.

Mr. Floyd: 22 degree.

Mr. DeVoy: 22 degrees, all right. The Chicago, Milwaukee & St. Paul Railroad from Milwaukee to Chicago has perhaps ten per cent of curvature. Of that ten per cent perhaps the average degree of curvature would be something like from three to five degrees. If the total resistance of a square truck over and above a loose truck is 40 per cent greater—I will accept the statement made in the paper—then the total resistance of the square truck over and above the loose truck would be directly in proportion to the amount and degree of curvature on the main line of any railroad. I am discussing this now in my own way, just along the lines of what I remember of the report. In my report I said that if all the railroads were taken together and computed identically on the lines as stated in this paper, there would be a difference of between five and eight per cent more resistance due to a square truck than to a loose truck. That is from this paper, according to my calculation of curvature. I assumed, and was told by Professor Endsley and Mr. Floyd, that there was not any difference to be expected on a perfectly straight track, as to the rolling, on the trucks. I guess I am right in this, am I not?

Mr. Floyd: I did not get that.

Mr. DeVoy: There is absolutely no difference in the rolling motion on a square or a loose truck on a perfectly straight track?

Mr. Floyd: Not unless your wheels get to be in bad shape.

Mr. DeVoy: Well, they were not, so you get the gist of my argument, that you don't get anything on a straight track at all. There is no difference in them. There is just the difference that the percentage of curvature, the total percentage of curvature, in your line amounts to. In other words, a line that has got a whole lot of curves, so you can see the back end of the train eight or ten times in a hundred miles, like it is on the North-Western, why, then you lose something, while as it is over the Milwaukee line, where there are no curves, you would not lose anything (laughter).

After you have made dynamometer tests for ten years as I have done—the fuel agent the other day said: "For God's sake, what are you making all these tests for? We made them over the same piece of track the same times with the same cars, and we are further in the soup now than we were when we started." So after you have made the dynamometer test to determine, where are you at?

Now to be serious for a minute, gentlemen, the first thing to be considered is the matter of safety, and no man ever lived that advanced the theory to me that the loose truck was a dangerous one so far as derailment is concerned. On the Milwaukee road we have a truck that has been in service twenty-eight years, and I asked the Superintendent of Motive Power the other day if I made a true statement when I said it never went off the track, and he said I did, and if you don't believe me I hope you will say so. I don't remember of one of those lateral motion trucks going off the track. There are no patents on it, I haven't got anything to sell, believe me; I don't own a steel foundry; I am not going to take any of your business. But I have never known that truck to go off the track.

Mr. Schroyer: What is it, a square truck of a flexible truck?

Mr. DeVoy: You know what it is; it is a flexible truck. I don't know who invented it, I have never looked up the history of that, but it has been in use twenty-eight years.

Mr. Schroyer: No better square truck was ever built than that.

Mr. DeVoy: That truck has absolutely no rigidity whatever. The bolster swings laterally. On top of the bolster itself is a small roller side bearing, permitting the car body to move say three or four inches. It has been proven absolutely, has it not, Mr. Schroyer, to-night, by the paper, that an arch-bar truck is not a rigid truck, and I say now that it is not. It is an arch-bar truck. So I say that the first thing to be considered is the safety in the truck. I believe this truck to be one of the best trucks, so far as its absence from derailment is concerned, that I have ever seen, and what is to be gained by this is more than I know. There is not any question in my mind but that we must come to a cast steel side frame, and there is not much difference in the cast steel side frames as I know them to-day. That includes the whole line. We must come to that, for the reason that you can put one of them together in erecting cars with much more rapidity and repair them with much more rapidity than you can an entire truck. If you don't believe that, Mr. Schroyer, come over to Milwaukee and I will show you.

Mr. Schroyer: That is what you have got to do.

Mr. DeVoy: And you can go back home and you won't have to do anything, you will be in the same boat that we are.

Mr. Schroyer: I think, Mr. Chairman, I would like to say a word as regards trucks and trucks. Now when we talk about trucks you think about trucks, and there are as many different kinds of trucks to-day as there are different railroads building cars, and the truck that I have always considered as being a flexible truck is the arch-bar truck to which two columns are bolted between the upper and lower arch-bar. The spring flange rests on the lower arch-bar and the truck bolster is directed by means of guides

on the columns on the truck. Now that is a flexible truck. The truck that is now known as the "Bettendorf" truck is a flexible truck although it has solid ends. It is flexible to the extent that there may be any loose motion between the truck end and the spring channel, which is not bolted to the truck ends. That I would consider a flexible truck. You take the old style swing motion truck that had a truck head the upper and lower plates of which have flanges extending up over the sides of the arch bars and the truck head bolted securely to the truck transom timbers and the arch bars in turn bolted securely to the truck timbers and the truck head, makes a squarer truck than the truck which Mr. DeVoy is talking about and which has been used for twenty-eight years on the Milwaukee & St. Paul road and a greater number of years on the North-Western road. We would never have departed from the use of this truck had it been possible for us to continue in use a car of 60,000 pounds capacity, but we found in designing a car of a greater capacity that it was not practical for us to get the hanging apparatus and get any reasonable dimensions that would be suitable for the heavier capacity car. The result was that we abandoned that style of truck and took up what is known as the rigid beam truck. For that reason I make this explanation in defense of the swing motion truck, which was as near a rigid truck as any ever constructed.

Mr. DeVoy: Mr. Chairman: We have that same truck in 60,000, 80,000 and 100,000 pounds capacity under all our high speed passenger trains. We have upwards of seventy-five in use now, and I want to say to the North-Western people if they will come over to Milwaukee we will show them how to get something larger than 60,000 pound capacity in that style of truck. We have 175 engines, 100 of which have 80,000 pounds capacity trucks, the other 75 having 100,000 pounds capacity trucks. There are no 60,000 pound trucks in any of them.

I want to go just a little farther and say that so far as the bolting together is concerned I don't think it does any good. We have a casting between the bolsters, between the column bolts and the upper and lower arch bar. I don't believe there are to-day fifty per cent of those castings solid. As soon as they break or crack up through the center we put in a bolt to hold them from spreading apart, and let them go. So that they are not rigid, and I do know that one side will move as much as an inch and a half.

The Chairman: We would like to hear from some of the other gentlemen.

Mr. C. A. Seley (C. R. I. & P. Ry.): Mr. Chairman, I agree with Mr. Manchester that more reliable results can be obtained by an actual test of actual cars with the dynamometer than with single trucks in any sort of experimental way. We don't railroad with the single trucks, and while perhaps we deduce things from ex-

periments with parts of any apparatus, yet results as a whole I believe can best be obtained by tests of the actual apparatus. The question of the necessity for loose trucks or trucks which will allow for curvature depends, it seems to me, on the condition of the road, the amount of curvature. On looking that up on the Rock Island, I find that about 18 per cent of our total mileage is curvature, the balance being tangent, and the average curvature of that 18 per cent is, as Mr. DeVoy states for his line, between three and four per cent. So that if our line is a typical western line, as I think it is, it would seem that considerations of curvature are not of vast importance.

There is another question in my mind, however, that governs, and that is the question of safety; the question of derailment. I recall visiting with the Superintendent of Motive Power a large line south of the Ohio River and going through his shop, and he showed me some tender trucks of massive design, heavily ironed, and in every way calculated to remain square, and he said to me, ''We have no end of trouble with those trucks getting off the track.'' He said ''Come over here,'' and he showed me another truck, with bolts and parts hanging down loose and practically no device that would keep the truck square. He said: ''That truck don't get off the track at all, we don't have any trouble with it,'' and it is a discouraging fact after a man has done his best to make a square truck to have such results.

It seems to me further that in comparison in a large way of results of loose or square trucks on freight cars, that that could be ascertained very readily by the indication of flange wear. If we have an additional amount of traction necessary to pull a train, it is evident that increased amount must be due to friction. Friction means wear, and wear on a moving truck is on the flanges of the wheels, so that I think most any one can determine for themselves as to whether they have an extraordinary amount of traction, as shown by their wheel flanges.

A Member: Mr. Chairman, I would like to ask if there is anything in the test which shows whether or not the truck went back to square after striking the tangent. In actual service, in my experience in railroading, it does not seem to me that it always does.

The Chairman: Will you answer that now, Mr. Floyd, or later?

Mr. Floyd: I will answer it later.

The Chairman: Any other gentleman? Mr. Downing.

Mr. I. S. Downing (L. S. & M. S. Ry.): There is no question in my mind but what if a square truck could be built square and held square it would be all right. But the trouble with the square trucks we have to-day is that they do not remain square. They are built out of square and they are run out of square, and it would be a pretty hard matter to put on enough inspectors in car shops

to see that the trucks are square when they come out. I have witnessed tests with loaded cars with both square and loose trucks dropped down over a great many curves and cross-overs, and those tests showed that there was practically no difference between rigid and loose trucks.

Mr. DeVoy: Mr. Chairman, I have an appointment in the morning and have to go home now, and in as much as Mr. Schroyer made a motion that the writer of this paper be complimented I want to second that motion. I hope it will be brought up at the close of the meeting. I don't think that there is any one experiment that has been made in American railroading or for American railroading in the past ten years, unless it be some of the Pennsylvania locomotive tests, that has thrown more light on a subject with which we were not entirely acquainted, then the test at Granite City, and there is not any question in my mind but that more than the thanks of the entire railroad community are due to the American Steel Foundries for what they have done. There is not any question in my mind but that it will be run down until we finally find out just what it does amount to in money. And I want to second that motion to thank them for the very able paper.

The Chairman: Has any other gentleman anything to say on this paper? If not, we will ask Mr. Floyd to close it for this meeting.

Mr. Floyd: Mr. Barnum brought up a subject that I would like to say a word about. It is a pretty hard thing to say or a pretty hard thing to calculate what might be the results with the dynamometer car test, if you could get at the same measurements in service that we have on that single track.

We are rather inclined to believe that our results are a little below what they should be. For instance we had some 54, I think, different trucks on the track taken right out of the cars in service. The car would come into our yard loaded, and we would unload it and jack up the car and take one truck out on our track. We took cars just as they came, some with new wheels, some with old wheels, and all sorts of conditions, probably an average condition, and the average drawbar pull on straight track that we got of all the trucks we had on the track was 6.3 pounds. Now I think in calculating what an engine can pull on a railroad the ordinary amount is really more than that. I had a talk with Mr. Keisel of the Pennsylvania road one day last week, and their formula gives 13, I think, and a little over. There is one other formula that I saw the other day that gives 9, another one 8, and probably none as low as the average that we have. We had trucks on a straight track that gave the drawbar pull as low as 3.2 pounds, and we had trucks on a straight track that gave us almost 13 pounds. The variation on the straight track was almost wholly wheel conditions. For instance, in this year's work, while it has not been completed, we made a very interesting

test not long ago showing the difference between new wheels on new rails and from old wheels on the same rails, and the same truck, the same conditions exactly, except the exchange of wheels, and the friction for the old wheels was nearly four times the friction of the new wheels. And we find that there is a big difference between the friction of the same wheels on new rails and on old rails. Mr. Manchester spoke of a dynamometer car test and so did Mr. DeVoy. That is a thing which we hope the railroads will make themselves, and one object we had in making these tests was to lead up to that point. But there are several things in making a dynamometer car test that it is not possible to find out, which you can find out, in a test of this sort. For instance, in making the dynamometer car test there are so many factors entering into it that it would be very hard to differentiate out any one thing and say that it does have so much to do with it or does not have so much to do with it, especially in view of the fact that the wheel condition alone will make two or three hundred per cent difference in the dynamometer car readings. We take a train of cars with new wheels and make a dynamometer car test, and take that same train after it is half worn out or almost fully worn out and you get an entirely different result. And in making a dynamometer test, you take a train of cars just as they come and you can't get down to the final analysis of any one particular thing unless you get what the wheel condition was and what the rail condition was. This whole question that we have been experimenting with is entirely a curve matter, curve friction. We set out to deal with nothing but curve friction.

Answering another question, about how quickly the truck straightens itself, the truck would straighten itself out on the straight track, a single truck, in probably one or two rails. But in actual service they probably don't straighten themselves so quickly. For instance, I examined a six degree curve on the Missouri Pacific Railroad last Sunday. The rails had been down about nine months. It is a curve that takes all of their traffic leading out of St. Louis. The curve has, I think, some eighteen or nineteen rails in it, and the rails are worn almost the curve shape by this time, about nine months, and that wear is indicated on the tangent after it leaves the curve for thirteen rails before it entirely disappears. And that is probably a condition that goes along with each individual curve.

Mr. Manchester: Will you allow me to ask you one question that has just occurred to me. The wheel troubles that you referred to, of old wheels, don't you find them generally on one flange? Do you find a worn flange on both wheels on the same axle?

Mr. Floyd: Well, if they are mismated, no.

Mr. Manchester: Suppose they are not mismated? The thought is this: If the wheels were not mismated, and there was just as many left hand curves as there was right hand curves on the railroad, then the flange wear would take place on both wheels, would it not?

Mr. Floyd: Yes.

Mr. Manchester: That would be the proposition. Do you ever find a wheel that way in any of your tests?

Mr. Floyd: Yes, we found wheels that were worn alike, both of them, and they were usually well mated. If we found a pair that was not well mated in the trucks we tested, one wheel was usually worn more than the other.

Mr. Manchester: That wheel flange proposition is a serious one, probably one of the most serious ones the railroads have to contend with. It comes about, if I understand the situation rightly, because we don't know how to mate wheels together of the same hardness; the rules we have for that purpose are not fine enough to really enable us to mate our wheels correctly, so consequently from the very start one wheel commences to wear faster, and in a very little time indicates a mismated wheel. But if the truck was responsible for the wheel flange, wouldn't we naturally expect to get both wheels wearing on the same axle?

Mr. Floyd: We would if we had the same—

Mr. Manchester: And I believe that most any railroad man present will tell you that 95 per cent of the flange wears occur on only one wheel on the axle.

Mr. Floyd: I don't know about that. I know of a very interesting thing that happened when I was connected with the railroad. We had six mail cars that made a run of 900 miles, and we discovered that the wheels were all wearing sharp on one side, the south side. We went to the engineering department and found out that they curved mostly one way in the 900 miles. After we equipped the cars with new wheels and turned the cars after each run we got practically the same wear on each side.

Mr. Schroyer: May I ask Mr. Floyd a question? Are you trying to demonstrate in these tests that you are making that the square truck will produce less sharp flange wheels than the flexible truck? My understanding has been that you are trying to demonstrate that there is an increased friction of the flexible truck around curves.

Mr. Floyd: Yes.

Mr. Schroyer: And that increased friction results in the wearing of rail heads?

Mr. Floyd: Yes.

Mr. Scroyer: A corresponding amount of wear on flanges of wheels, but which we in actual practice never find on the flange?

Mr. Floyd: If the friction is more on the curve, the friction is certainly between the flange and the rail, certainly either one or the other must wear. You will find if you investigate very carefully that there is a different shape to the flange, the shape it finally wears into, on the loose truck, than there is on the square truck.

The Chairman: Mr. Floyd, may I be allowed to speak for a minute? Before this so-called flexible metal truck went into

service, I had some conversation with certain parties in regard to the same, and a few days after we had one of our ballast cars in on the repair track for trucks to be rebuilt. This car had been in service over six years. It was a wooden flexible truck. The only thing that held the truck together was the truck bolts. The wheels under that car, each one of them, showed the same wear, almost identically, and that wear was in the throat of the flange, not sharp, nor did it extend up on the flange over one half inch. We examined all the wheels in the car and that was the condition we found them in. So if the wheels, to my mind, are closely mated in a flexible truck, they will wear almost identically alike, in my opinion. Mr. Floyd, do you care to say anything further?

Mr. Floyd: I have said all I care to say.

The Chairman: Gentlemen, before we entertain a motion of thanks, I would like to have some suggestions as to continuing the discussion of this paper at the next meeting. It is a very interesting paper, and possibly after it is printed and you have all read it you will find more in it than has been developed this evening.

Mr. Schroyer: Mr. Chairman, I move that the discussion of this paper be continued to the next meeting and be taken up as the first order of business.

The motion was seconded and carried unanimously.

The Chairman: Now I will entertain a motion of thanks.

Mr. Scroyer: I move that it be the sense of this meeting that thanks of the members of this club be extended to Mr. Floyd for the very able and instructive paper he had presented this evening.

The Chairman: Is this the motion that has been seconded by Mr. DeVoy?

Mr. Schroyer: Yes.

The motion was put and carried unanimously.

The Chairman: Gentlemen, I wish to thank you for the strict attention you have paid to this paper. I believe, without being egotistical or anything of that kind, that fewer persons have left the room this evening than at any meeting that I have known for quite a long time.

A motion to adjourn will now be in order.

On motion, the meeting adjourned.

THE DAVID L. BARNES LIBRARY

SPECIAL NOTICE.

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, October 17, 1911, President C. B. Young in the chair. The meeting was called to order at 8:30 P. M. Of those present the following registered:

Bentley, H. T.
Bloom, A. B.
Barnes, C. A.
Beattys, W. H., Jr.
Brown, C. L.
Casgrain, G. D.
Cizek, J. J.
Constant, E. J.
Covert, M. F.
Cram, T. B.
Dalman, J. W.
DeVoy, J. F.
Dix, G. E.
Dunham, W. E.
Dunn, T. F.
Flavin, J. T.
Frame, R. E.
Gale, W. T.
Gilbert, H. H.
Gilpin, G. G.
Good, C. S.
Goodnow, T. H.
Grieves, E. W.
Hills, G.
Hooper, B. C.
Jones, L. E.
Jordan, J. B.
Lammedee, J. M.
LaRue, H.
Laughlin, G. F.
Lovell, C. P.
Macpherson, A. F.
McAlpine, A. R.
Morehead, L. B.
Morey, E. H.
Motherwell, J. W.
Murphy, G. A.
Naylor, N. C.
Olmstead, C. J.
Prehn, Martin
Reed, C. S.
Schwarz, Michael
Scott, H. M.
Seley, J. S.
Sharp, W. E.
Shearman, C. S.
Silk, E. E.
Simons, J. E.
Smith, W. E.
Stall, W. B.
State, R. E.
Stocks, W. H.
Strubel, C. H.
Sweringen, F. H.
Taylor, C. W.
Taylor, J. W.
Thayler, A. L.
Thurnauer, G.
Toohey, M.
Walsh, W. J.
Winn, C. F.
Wright, A. H.
Young, C. B.
Zealand, T. H.

The President: The first order of business is usually the approval of the minutes of the last meeting, but unfortunately the printer has not got them out yet; you have not received them, and they will therefore be laid over until the next meeting.

Next in order is the report of the Secretary.

MEMBERSHIP STATEMENT.

Membership, September, 1911	1,574
New members approved by Board of Directors	7
Total membership	1,581

NEW MEMBERS

Name	Occupation	Address	Proposed by
O. Lundehu,	C. D. Swift & Co.,	Chicago	M. F. Covert
W. A. Bennett,	Griffin Wheel Co.,	Chicago	J. W. Taylor
J. B. Jordan,	Crane Co.,	Chicago	F. D. Fenn
B. C. Hooper,	Railway Malts Co.,	Chicago	J. W. Taylor
F. G. Dunbar,	Sargent Co.,	Chicago	H. H. Gilbert
Robert C. Black,	Sept. App., C. O. N. W. Ry.,	Chicago	W. T. Gale
Michael Schwarz,	Manager Alcohol Utilities Co.,	New York	W. E. Sharp

The Secretary: Those are all the reports, Mr. President.

The President: At the meeting last month we had a very interesting paper on experiments with rigid versus loose trucks. The discussion was not finished, and it was decided to take it up again at this meeting as the first business of the evening. I suggest that Mr. Floyd, who read the paper last month introduce the subject briefly again for the sake of starting our members in on a good discussion.

The Secretary: The original paper presented by Mr. Floyd appears in the September, 1911, proceedings.

Mr. G. G. Floyd (Am. Steel Foundries): I do not know that I can say much more on the subject than I said before, except that I might say something in reference to the experiments we have made this summer which are now about completed, but as the paper dealt with a somewhat different subject, I hardly feel like introducing a new subject, and I have thought of mentioning part of this summer's work only at the end of this discussion. I was a little disappointed at the last meeting that the matter was not discussed more than it was. I realize, however, that the members were somewhat at a disadvantage because they had not had the paper to read. Unfortunately I was not informed that I would be called upon to read the paper until just a day or two before the meeting, and had not had time to get it in shape for the printer. As the paper has been distributed now in time to have allowed the members to study it, I do not believe that I will add anything more to the paper itself, as they will be able to discuss it better now than before.

I might say, Mr. President, that discussing the matter to-day with one or two gentlemen, they seemed to think that the data we have put out, was put out with the idea that it is actual service conditions, that is, where we mention the drawbar pull per ton. It is not our intention, and I think if the report is read carefully, it will be seen that we do not claim that this will be the same in

actual service. We put those figures out only as representing what we got on our experimental track, but we believe it will be somewhat close to what actual service conditions are from the fact that we had a piece of straight track later in the season and the results that we got on that compare rather favorably with the usual formula for straight track and as formulas for curve friction vary so considerably, we believe that our results as to curve friction are probably as near correct as any formula that are being used now for curve friction. The same trucks that we tested on curved track we tested on straight track as well, and the friction that we got from those trucks on straight track compares rather closely with the ordinary railroad formulas for straight track friction.

The President: I was not present at the meeting last month and I don't know who of you entered into the discussion; I don't know how fierce it was, but I hope there are enough of you left who did not ventilate your ideas last month to give us some very good ones this time, and those who did speak last month have probably thought it over more and can add to it at this time. The meeting is open for discussion. Mr. Seley, did you say all on that subject last month that you wanted to?

C. A. Seley (C. R. I. & P. Ry.): I believe I did. Nothing occurs to me that I would care to add to the discussion. I think it was Mr. Schroyer who was responsible for continuing the discussion, and I think if I had a second, I would be inclined to move a resolution of censure upon him for not attending to his business. I do not believe that I have anything further to add, Mr. Chairman.

The President: I think Mr. Bentley can probably take the place of Mr. Schroyer who moved that this discussion be continued.

H. T. Bentley (C. & N. W. Ry.): Mr. Chairman and Gentlemen,—I have read the paper over, but I am not in position to discuss it. I do not want to take the responsibility of taking up the time of this meeting tonight with something that Mr. Schroyer ought to have been here in person to have done. It certainly is a very interesting paper and some of the results reported are remarkable. I am not able to analyze why they should be, but it would seem to me that if the results are as tabulated, we certainly cannot afford to use the loose trucks anywhere, but that seems rather a drastic thing to say, because we have so many of the loose trucks in service. I will be very glad to second Mr. Seley's motion of a vote of censure to Mr. Schroyer, if that was a motion.

The President: I think it would be out of order to censure any of our past presidents. Mr. Forsyth, have you given this matter any thought that you would be glad to let us know?

Mr. Wm. Forsyth: I have thought a great deal about it, but I cannot speak of it.

The President: It appears to me from reading over this paper that the author assumes that the railroad men of the country, the mechanical men of the country, have been mistaken, or else that they have not given the matter any thought whatever; that they have been negligent of their duties. We were told about a year ago that the railroads could save a million dollars a day; they had been so careless, they had allowed things to go at such loose ends that a million dollars a day could be saved. That rather startled the country. We did not know that we had been so negligent before. The author of the paper seems to assume that the mechanical people have been asleep, and on page 9 he says, "It seems somewhat remarkable, considering the age of railroads in this country, that such a test was made only last year evidently for the first time." I do not believe that the mechanical men have been blind in this matter, and I have some remarks here with that paragraph as a text, which I will ask the secretary to read.

The author makes a statement in which he says that it seems somewhat remarkable considering the age of railroads in this country that such a test was made last year evidently for the first time. From the above it would seem that our railroad officials had been negligent in their study of tractive efforts. However, is it not likely and in fact probable, that if such differences as were found in the Granite City tests actually existed in service conditions, that our railroad men would have discovered at least some trace of this condition in our every day practice. In fact when it is found impossible to increase tonnage rating without producing delays and hindrances in our train schedules, by even a few tons, it seems to me highly improbable that trucks exist at the present time having a difference of 15% in the pulling power required, without such difference making itself known in our every day service.

As I look at the question of curve resistance, it seems to me that those conditions mentioned in the paper pertaining to center of gravity, side bearing clearance and so forth, actually mean more than would appear on the surface. For instance, increased resistance on a curve is probably due in the most part to the increased length of the outer rail as compared with the inner rail, meaning that one wheel must slip or the other slide, in order that the truck may round the curve; and this increased resistance will in amount be proportionate to the weight on that wheel which slips or slides. The center of gravity of the load together with the centrifugal force plays quite a part in determining the resultant weight on either side of the track according to whether the center of gravity is low or high. The center of gravity of the test truck as used at Granite City I understand was probably not over 24" above the rail, whereas the center of gravity of

loaded cars probably varies from not less than 40″ on flat cars loaded with steel rails, to 80″ or more with beef cars having the load suspended from the roof. This change in height of the center of gravity from service conditions to the test conditions will mean that the centrifugal force under the test conditions will have less tendency to lift the inner wheel from the rail, than will be the case in service. This tendency to lift the inner wheel from the rail means a tendency to reduce the effective weight on that wheel, hence means a difference in the resultant resistance due to the inner wheel slipping.

The question of side bearing clearance and oscillation force will also play a part since during the periods of oscillation an impact will be brought to bear on first one side bearing and then the other. Whatever force is brought to bear on one side bearing probably means an equivalent force relieved from the other side bearing consequently, relieving the wheel of such an amount, and if slipping or sliding takes place at such a period, the force of slipping or sliding will be much less than it would be if the greater load was effective at that time. When all of these features are considered, it seems to me we are justified in assuming that the tests as conducted at Granite City are not sufficiently near service conditions to warrant taking Mr. Floyd's statement as a serious criticism on the efforts of railway mechanical men in not discovering these differences in truck resistance which were found at Granite City.

By the foregoing I do not wish it understood that I am casting doubt on the tests as conducted, for I can readily believe that the data as presented was warranted and justified by the tests as made, but I do most firmly believe that the tests do not represent service conditions, and question if the results obtained from road service conditions would justify any severe criticism to railroad men for not having discovered what is presented in the tests.

Question 1. I would like to ask Mr. Floyd, if in his opinion, there are any perfectly square trucks in extensive use at the present time.

Question 2. I would also like to ask if the roads using these trucks have increased their tonnage per train when handling these trucks only.

Question 3. I should judge from the paper that we are expected to believe square trucks pull at least 15% easier on five and one-half degree curves than do loose trucks. I would ask if those of us responsible for locomotive rating would not find ourselves in deep water if we should arbitrarily increase tonnage 15% when all trucks are square and have the riveted spring planks.

Question 4. The information which has been given us would be of more interest to me if I felt that the tests were more in accordance with service conditions. However, at the best the

15% to 24% mentioned can only pertain to the difference between square and loose trucks on level curved track, and even this will be reduced in amount with any up grade, and I would like to ask if I am not right in assuming that this difference becomes practically nothing on mountain grades even though the curvature is considerable. For instance, in mountain territory sometimes as much as 30% of the track mileage may be found to consist of curves, but where the grade is from 3½% to 4% it strikes me that the difference in curve friction will be practically lost in the sum total of all other resistance, and when both grade and straight track are considered I believe it will be hard to find any great economy resulting from even the difference of 15% to 24%, and personally I question if this difference exists in actual practice, for if so some one would have discovered it when rating engines, especially so on roads which are inclined to rate their engines as high as possible.

Question 5. The paper presents some very interesting data illustrating what takes place with a single truck on a curve where momentum or inertia is the source of power. I understand the plan of using a complete car in making these tests was rejected because they had in mind only one thing, that of determining the flange and rolling friction as influenced by the truck getting out of square. Mr. Floyd states "that in using complete cars there would be introduced so many other factors and complications that it would be practically impossible to separate the friction due to any one factor alone. With a car there would have entered into the result the friction of center plates and side bearings, the spacing and clearance of side bearings, the center of gravity of the car, its length and various other things so that it would be impossible to measure or even estimate what per cent of the whole result could be charged to each individual factor."

To me it seems that the foregoing factors constitute through their elimination a vast difference between the tests as conducted and our daily operation of freight cars. In fact, I believe mistakes are constantly being made in railway tests where a large number of variables play a part by endeavoring to eliminate all variables except those under consideration, and in so doing many service conditions are lost through not having all effects active at the same time. For example, if the car body has been eliminated in truck tests would we not be justified in eliminating the truck itself if we were to test for resistance of individual pairs of wheels; to do the latter would produce results which I believe all would consider ridiculous. However, to return to the factors of center plate friction, side bearing clearance, and height of center of gravity, I would like to ask how these factors should be treated in conjunction with the 15% when considering tonnage rating and the relation between square and loose trucks.

Question 6. The paper makes quite a point of wheel conditions and states that between the best and worst loose truck there was a difference of 80%,—40% of which was due to truck construction. If the wheel conditions play such an important part in the pulling power required, will not this same improper wheel condition cause a square truck to prove a detriment on straight track, insomuch as the squareness or rigidity will not permit wheels of improper form to adjust themselves to as good a position as they would with a flexible truck.

The President: Mr. De Voy, I did not hear what you said last time. I know you can give us something this time that will be interesting.

Mr. J. F. De Voy (C. M. & St. P. Ry.): I do not believe you want to hear what I had to say the last time. They found some fault with the manner I conducted business last year and I tried to defend myself. The only thing I am doing down here tonight is to try, if possible, to have a little to say about my friend Bentley. That is the only thing that brought me down here. I wanted to know if he knew anything about welding. The Northwestern certainly don't do anything by halves and I thought we had better get into the game with the Northwestern, if it was possible to do so.

If the secretary will read my corrected remarks, about the last fifty words, it will contain all that I have to say about the square or the loose truck. If the Secretary does not want to read it, I want to say, first of all, that I do not want to get into any trouble with the American Steel Foundry Company in any way. But there have been tests made and plotted in which there is a resistance due to a loose or square truck which diminishes directly as one line will pass through another on curved and straight track. I have knowledge that such road tests have actually been made, and I am just as well satisfied that they are correct as I am satisfied that the tests conducted by Mr. Floyd are correct. But it is a positive fact that has been demonstrated by road tests, that whatever is gained by the square truck on curves is lost on the tangent. I would rather have my corrected words read and they represent exactly what I know to be the fact, and I do know so far as I am concerned that railroad people have not been negligent in their duty and have allowed things of this kind to go on. That is all I have to say, Mr. President.

The Secretary: I might say for Mr. DeVoy that his revised remarks were received at the office too late to be printed. I had to get the papers into the press, expecting to get them out for this meeting. I corrected his remarks as best I could so as to get the proceedings out.

Mr. De Voy: Then I want to say that I was under somewhat

of a strain at the last meeting and being unfamiliar with the crowd and conditions, my words did not express exactly what they ought to.

The President: I understand, Mr. Bentley, you can tell Mr. De Voy just exactly what is right.

Mr. Bentley: I will try to a little later.

The President: Mr. Goodnow, have you anything to say on this subject?

Mr. T. H. Goodnow (L. S. & M. S. Ry.): I do not believe I have.

The President: Mr. Dunham, Mr. Schroyer is responsible for this paper being presented, and I think another Northwestern man ought to help him out.

Mr. De Voy: Mr. Chairman, it must bring out very forcibly to your mind the fact that it is not the Milwaukee road that is not doing anything, it is the Northwestern. You know they started this thing and now they do not appear to be able to finish what they started.

The President: Mr. Dunn, of the Pennsylvania, have you anything to say on this subject?,

Mr. P. T. Dunn (Penna. Lines): I believe not, Mr. Chairman. I was not present at the last meeting. I have no discussion prepared and I have not seen enough of the paper to say anything.

The President: If there are no further remarks to make, and Mr. Floyd cares to close the discussion, we will be glad to hear from him.

Mr. Floyd: It was not my intention in the paper to cast any reflection upon the engineering departments of various railroads, or to indicate that they had been asleep in the matter at all. We undertook to investigate this thing first by getting information from various sources, among others, the railroad men themselves, and we found, I might say, that the mechanical men were divided into two camps on this subject. A great many were perfectly honest in their belief that the loose truck is the best truck, a great many were perfectly honest no doubt in their belief that the square truck is the best truck, and we could not take their statements and their arguments and put them together and sift the thing down to a conclusion. They differed so radically on the point at issue.

Next we undertook to look through the literature and see if there were any tests exactly of this nature before. We did not find them, if there had been.

After investigating along various roads, we decided, in our own minds that there was a possible difference in the two trucks, because these differences manifested themselves in the condition of the trucks as found in service. The information we gathered

that way, however, was not entirely conclusive, and we started these tests with the idea of finding out, if possible, why we found trucks in certain conditions in service. We were only after one thing and we did not see, and the experts we called in on the question did not see how it could be arrived at in any other way except by testing a single truck, and the results we got we believe will hold out.

I have in mind trying to get various railroad dynamometer car tests together on the subject of curve friction. It is almost impossible to take a series of tests made by different railroads, put them together and get the same results. This comes about, no doubt, from the fact that such tests are usually made under different conditions, different rail conditions, different car conditions, and all these different conditions will make a difference in the final results. But in making the test as we did we got down to the one factor that we were investigating. I do not believe, at least as far as we know, that dynamometer car tests made in the past have gotten down to this one thing.

We found a certain condition of trucks in service that would indicate that there was a difference in the shape, for instance, of a sharp flange as between the truck loose and truck square, and we found a difference in the way the column guides will wear and several other things of that sort that led us to believe there might be a difference in the two types of trucks, if it could be tested out properly as to what influence these differences might have on train resistance. I believe, and our investigations seem to bear out the fact, that the majority of trucks in the United States are loose trucks, that the square trucks, in comparison, are so very few, that the influence of the square truck has not been felt on the total number of cars in the United States; they are put in the trains so promiscuously that they are not felt and would not be felt until the square trucks assumed a larger proportion of the total number of trucks in service.

We have just finished an experiment the past week in which we put gauges on trucks in actual service running between Kansas City and St. Louis, and with a very few exceptions we found that the trucks in actual service go out of square an amount about in proportion to the amount we found on the test track. We found that when we took one of our test trucks and held it out of square, a certain amount of friction increased a certain amount. If that truck goes out of square in actual service that same amount, it is reasonable to assume that the difference in friction in service would be somewhat in proportion to the difference in friction found on our test track. It is quite true that the other factors, the center of gravity and the center plates, side bearings and all those things have a large bearing. The condition of the wheel has a

large bearing upon the ultimate total resistance of the train, but the difference between a loose and a square truck will still exist and it will show in a train.

The President: Next on the program is a paper on "Oxy-Acetylene Welding," by Mr. H. T. Bentley of the Chicago & Northwestern Ry.

Mr. Bentley: Mr. Chairman and Gentlemen—I thought I heard Mr. De Voy say that he had come here to find out what I knew about oxy-acetylene welding. I just saw him slip down the elevator, so it must be that he is not very anxious to know, or he would not have gone out when he did. I do not know very much about the subject, but I brought it up, thinking that it will bring out something in the way of discussion.

OXY-ACETYLENE WELDING.

By Mr. H. T. Bentley—P. A. S. M. P.—C. & N. W. Ry.

To The Members: Having been asked to talk about something that would fill in the evening assigned to a further discussion on "Trucks," thought a few words on the subject of Oxy-Acetylene Welding might be of interest. I am not going to say anything about the chemistry of Oxygen or Acetylene, most of you know how produced and what wonders have been accomplished by the two gases in combination. It will not be necessary to give a lecture on the kind of apparatus to be used, whether oxygen under high pressure or low pressure is the most economical; whether the tank storage system or retort method of handling and manufacturing is the best, or, whether it is better to have the apparatus stationary and gases piped to the work or portable, to be taken whenever wanted. We have used both types and have our own ideas as to which is the best.

I want to briefly state that when beginning to use whichever system is decided on, there will be lots of disappointment in store for the man who thinks he can get immediate results, particularly so if you are making your own operator.

We began in a humble way about 18 months ago and thought inside of a week or two we would be welding up flue sheets, putting patches in fire-boxes, repairing castings and a hundred other things our friends had told us could be done so easily, but apparently nothing went right, a crack would be welded in one place only to open up again or start another in a different location. We had some comfort in the fact that even the so called experts fell down, one case in particular being fresh in my mind: A casting was broken which we desired to have repaired at once and, having oxygen and acetylene on the ground, thought it would be a good opportunity to let some of the people, (who were so anxious to show us how it could be done), have a chance at it, which we did, and with miserable results, the operator claiming the iron was so poor that he

could not get anything suitable to work on. After this, some of our men felt very discouraged at the results obtained and you could hear them saying ''I told you so'' but others were nearly as optimistic as I was, although after over four months' trials and tribulations, if a vote had been taken at that time, it would have been overwhelming in favor of dropping the whole thing. Finally, however, we were able to weld up some unimportant castings which gave us fresh courage. As we were having considerable trouble with cracked flue sheet bridges on certain engines, thought it would be a good thing if we could weld them up and, before trying it on a flue sheet in place, we got an old one and experimented for days with it, sometimes having more cracks at night than we started with in the morning; at last we appeared to have solved the difficulty and started on a flue sheet in an engine and all we had learned on the flue sheet that could expand and contract without having anything to prevent it, had to be learned over again when the sheet was held rigidly in place without an opportunity to move in any direction. We were, after considerable experimenting, at last able to handle this kind of work in a satisfactory manner, and all having experience with boiler work will appreciate what it means to be able to do a job of this kind on a flue sheet that is otherwise in good condition.

One morning we were confronted with a rush job which, if successful, would mean a good deal to us. A superheater locomotive was in the shops with a cast iron steam pipe cracked for a distance of 14″. Unfortunately, as it appeared at the time, we did not have a new steam pipe nor a pattern to make one, and the engine was badly needed, as engines generally are, especially when it looks as if you cannot get them. Fortunately, we had the oxy-acetylene apparatus and after a council of war, it was decided to try and weld up the steam pipe, although most of our men thought it could not be done satisfactorily. The attempt, however, was made, and much to our surprise a first-class job was the result, which tested out O.K. This gave us confidence and other jobs were undertaken, some of which turned out well and others were failures. At about this time we got hold of an operator who used his head while doing his work, and after that it was comparatively easy; nothing was too complicated to tackle and we are able to successfully weld up in fire-boxes, apply patches, weld in half side sheets, repair broken cylinders, weld up broken driving wheel spokes, build up worn parts on castings, air reservoirs, etc., repair broken castings of all kinds; so that now we cannot keep house without it. A saving of from $1,200 to $1,500 can easily be effected per month in a shop like ours by repairing things that otherwise would have found their way into the scrap; this amount simply covers the actual saving and does not in any way take into consideration the value of the time an engine or machine may be out of service.

The University of Illinois published a Bulletin No. 45 in September, 1910, on "The Strength of Oxy-Acetylene Welds in Steel" by H. L. Whittemore which should be read by all who think of taking up the subject, as it contains valuable data and would, if studied, save lots of wasted time and material.

In May, 1911, this subject was fully discussed after the reading of a paper on "Acetylene Welding" by Mr. J. M. Morehead before the New York Railroad Club and a list of the possible uses was given, which should be studied by any person thinking of going into the business, and for the information of members who have not had an opportunity of reading Mr. Morehead's excellent paper, am taking the liberty of quoting from it some of the things that can be done:

Reclaiming light and heavy castings from the sand with blow holes, sand holes, cold sheets, etc.

Reclaiming light or heavy cracked or broken castings whether of cast iron, cast steel, brass, bronze or aluminum.

Adding metal to parts that have been worn by friction, etc., making such parts serviceable as originally.

Repairing large or small boilers in place, welding in new parts or filling in cracks edge to edge.

Split piping of all kinds can be quickly welded when in place, usually without breaking connections.

Welding flanges on pipes.

Rivet heads quickly cut off and shanks driven out.

Tool steel can be added to common steel.

Bridges, boilers, arches, steamships, etc., can be wrecked by the cutting process.

Bolt and other holes worn beyond use can be restored to former size, etc.

Holes drilled in error can be filled in, dressed down and rendered undiscernable.

Teeth broken from gear wheels can be renewed.

In reading the discussion of the paper at New York, I was interested in noting what several motive power men had to say about their experience which had at that time been very limited, and it coincided so closely with what ours used to be that I could almost imagine it was our men talking as they did about ten months ago. I had confidence in the possibilities of the thing, but could not, for a time, get up much enthusiasm. All this had changed, however, and now if we are in a hole with some repair job, the first thing that is suggested is "try Oxy-Acetylene," and it seldom fails us. We do not recommend it for frame welding, as Thermit and oil does that more to our satisfaction than anything else.

It will be very interesting to learn what has been the experience of others and for that reason hope a very full discussion of the subject will be endulged in.

The President: Mr. Bentley, supposing you had a cracked cylinder head that had not given way, but was sputtering and spitting, how would you proceed to weld that cylinder?

Mr. Bentley: Shall I answer the question now or wait till the end?

The President: It might be well to answer all questions at the same time.

A Member: I should be glad if the Secretary will repeat that remark.

The President: The question is, if a cylinder head were cracked, but not broken, simply sputtering, you knew it would crack the next time the engine went out, how would you proceed to weld that up?

A Member: What does Mr. Bentley have to say to that?

The President: He has not answered yet. Suppose you answer now, Mr. Bentley.

Mr. Bentley: If it was a front cylinder head, cast iron, I do not believe I would weld it up, but if it was a cast steel cylinder head,—we use nothing but cast steel back heads—it would be a very easy matter to fill in the hole that was leaking with the oxy-acetylene and I am satisfied the hole would not extend any further.

The President: Then you do not fully agree with Mr. Morehead, who has given such a comprehensive list that I thought anything could be mended.

Mr. Bentley: Mr. Chairman, I think it is possible that a front cast iron cylinder head could be welded, but I believe possibly the cost of welding it might be greater than putting on a new one.

Mr. Hill: I should like to know if Mr. Bentley has any data.

Mr. Bentley: I think Mr. Gale can give you information on that subject.

Mr. W. T. Gale (C. & N. W. Ry.): If it is possible to weld up a cast iron steam pipe by this process and make it O. K., as Mr. Bentley has said has been done by actual experience, it is possible that cast iron cylinder heads could be preheated and welded over by the same process. I think it is possible.

Mr. Hill: I do not believe oxy-acetylene could weld up a cast iron cylinder in a satisfactory manner, because it represents a pretty stiff proposition when you come to weld cast iron, on account of the expansion and contraction and you cannot weld it all up in one weld. Of course, it is understood that these weldings were made where the cracks extended only two or three inches, but take a case of a crack extending over twelve to fifteen inches in length, that cannot be welded at one time, it must be done in little patches. I know it is a fact that by using electric welding it will be possible to weld the cylinder up in a satisfactory manner, even common cast iron. I would like to know if Mr.

Bentley has any data as to the possibility of making these welds.

Mr. Dunham: I should like to ask Mr. Bentley how this steam cylinder was handled on a fourteen-inch crack.

Mr. Bentley: The steam pipe was heated and an oxy-acetylene blow pipe was used with a piece of cast iron to weld into the crack and after a very short time a satisfactory job was made. Every job that we tackled, to start with, seemed to go wrong; we did not seem to be able to get any results at all, but after we got the hang of the thing and got a man who was familiar with the process, it was no trouble at all to do some things that apparently in the first place seemed utterly impractical. In regard to welding a cylinder, we had a consolidation engine 25 by 32 that had a piece broken out about fifteen inches long and four or five inches deep and Mr. Gale, who preceded me, can give a history of the way in which that was welded. The engine is still running with that large piece successfully welded into place by the oxy-acetylene process.

The President: Mr. Gale, I think that would be very instructive, if you will outline the method.

Mr. Gale: I might say it was one of the first and most difficult jobs we handled at that time. It was a very severe crack in the front end of the cylinder, on the cylinder face of joint; it extended at an angle of about 45 degrees to the inside port hole and I arranged for a series of brick, cement and asbestos and built a furnace fire all around the cylinder, and preheated very carefully to prevent any undue draft or cold air from striking the cylinder while it was being heated and we went to it with the blow pipe and cast iron filler. The operation took about seven hours, I should say, to successfully complete the job. After we got through we found that there were two or three small air holes there that emitted a little steam when the engine was fired up, but after a little while, with a little riveting with a small hand hammer, it was taken up and that engine has been in service, I believe about five months and we have had no difficulty with it since. It was rather a difficult operation and one that we were a little afraid of, but we had considerable courage and handled it with the understanding that if we could not make a success of it, with the oxy-acetylene, we could still resort to our old methods, but it was a success. That was cast iron of course.

The President: Mr. Seley, what is the Rock Island doing?

Mr. Seley: Mr. Chairman, we have an oxy-acetylene outfit, but I have not been close enough to the operation to really know what success we have had with it. I rather think it has been successful in the smaller cases, but whether they will undertake anything in a large way I could not say. I regret not having any information.

Mr. Bentley: I should like to say for Mr. Seley's information

that we were able to get a lot of valuable information from the Rock Island road at Silvis, when we were starting in with this system. We did not believe it was possible to do some of the things that the people had told us and some of our men went to Silvis and spent a long time there and were given a great deal of valuable information which enabled us later to reproduce some of the results that they had shown us, and we wish to have it understood that the Silvis shops are responsible to some extent for our success.

Mr. Floyd: I am not a member of this club, but I should like to make a few remarks.

The President: I have been thinking that some of these experiments would be very useful in a Steel Foundry.

Mr. Floyd: I want to raise the question along a slightly different line, to see if railroad experience has been anything like ours. We have two kinds of gas and one electric machine, three kinds. Some six or seven years ago we employed quite a force of blacksmiths. When a casting came from the foundry and it was not quite filled out, had a drop in it, or scab on it, or a hole in it, it was sent to the blacksmith shop and they fixed it up in pretty short order. But we soon found that the knowledge that a casting could be fixed created a sort of carelessness all through our shops, especially the foundry department, and the quantity of work that we had to send to the blacksmith shop kept increasing from week to week. Finally it got to be quite a respectable portion of our whole output, and it got to such a point that we finally, after canvassing the situation pretty thoroughly, discharged our blacksmiths and stopped the blacksmithing. We told our foundry foreman and the various heads of departments that this work must come out of the foundry without having to go to the blacksmith shop. For some two or three months our foundry loss on castings that were scrapped by the inspection department ran as high as fifty per cent, but after everybody thoroughly understood that there was going to be no blacksmith work it dropped down in the course of three or four months to normal. Some two or three years ago, the gas people got after us and various electric men came to us to see if they could persuade us to put in either one kind or the other kind of gas or electric machine to weld or patch our castings, which we knew could be done all right and we have debated the question for nearly three years, feeling that there was a possibility if we did install a gas welding machine or electric welding machine, that we might get back into the same rut we were when we were welding things in the blacksmith shop, and it is only in the last few months that we have put in a welding machine. We have had a gas outfit and electric outfit, but the castings that are welded are not sent to these machines by any of our foremen. There is no casting welded with either gas or elec-

tricity but that is passed upon by the management of the works and the engineering department. We do not allow any foreman or sub-foreman to say what shall go to the machine to be welded and we have taken that action in order to keep up the good work of the foundry, so that there will be no let-down on their part, and it occurred to me when Mr. Bentley was reading his paper that if the railroad shops should find that almost anything can be welded, I was wondering if they might not in the course of time find that they would have the same sort of carelessness and that there might possibly be something welded, or attempted to be welded, that might better have been scrapped and no attempt made to weld.

Another point that I should like to raise, I should like to ask Mr. Bentley if he has had any experience with the oxy-hydrogen. We have used both the oxy-acetylene and oxy-hydrogen and we use them for different purposes. We use the oxy-acetylene largely for cutting off gates that are less than three by five. If we have a gate or a piece of metal that has to be cut that is over three by five, we use the hydrogen. If we have a hole in the castings that just merely wants to be filled up largely for looks, we use the electric machine. One of our works managers claims that the oxy-hydrogen mixed with 30 per cent acetylene is better than the oxy-hydrogen or oxy-acetylene alone.

The President: Mr. Floyd, in welding for strength—

Mr. Floyd: We do not weld for strength.

The President: Well, you probably have made some experiments.

Mr. Floyd: Yes.

The President: In welding for strength, would you recommend the electricity or the hydrogen or oxy-acetylene,

Mr. Floyd: I should think, as far as our experience has goue, that it is possible, if the section is light, that oxy-acetylene might be better. I meant to state that we do not weld for strength, we do not allow any welding to be made on a tension member. The oxy-acetylene flame for welding we consider a little softer flame, it does not burn so quickly, that is the reason we use the hydrogen flame for cutting. We can cut through a 12-inch bar with hydrogen where we could not cut through a more than four or five inch bar with the oxy-acetylene. Because the hydrogen seems to be a much harsher flame, it cuts best.

The President: Any further questions or discussion of this subject? Mr. Bentley, did you take note of the questions which Mr. Floyd asked?

Mr. Bentley: In regard to what Mr. Floyd had to say about a possible letting down in the quality of the work at a foundry, you see we are not in that particular condition that Mr. Floyd is.

We get our castings from different firms and we reject the castings if they are not absolutely all right when they come to us, and we do not fix up defective castings that are furnished us by the manufacturer. We simply, when a casting has become broken in service, resort to different means which we can decide are the best for repairing it and in keeping it in service. About the oxy-hydric process, I investigated that three or four years ago with a firm that was manufacturing it, and at that time the cost was prohibitive and we did not do anything with it and finally got into the oxy-acetylene business and we have found it was so satisfactory that we have not thought of going back to anything else.

I made a statement that I did not think it was advisable to use oxy-acetylene for welding frames, and I do not know whether I think it is yet, but the other day we had an engine with a frame that was broken half the way through from the bolt hole down and we used the oxy-acetylene torch on it and so far the engine has been in service for about a week and is doing all right. But I am a little bit sceptical as to whether a broken frame, probably five by five, is a proper subject for acetylene welding.

The President: Is there any further discussion on question? If not, a motion to adjourn will be in order.

Mr. Seley: Before doing so, I would move a vote of thanks to the author of the paper.

The President: It is moved and seconded that a vote of thanks be extended to the author of this paper. Those in favor, please say aye. It is carried.

Adjourned.

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SPECIAL NOTICE.

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OFFICIAL PROCEEDINGS

OF THE

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The regular monthly meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, November 21, 1911, Vice President T. H. Goodnow in the chair. The meeting was called to order at 8:30 P. M. Of those present the following registered:

Alexander, W.
Arlein, A. J.
Berges, A. H.
Blatchford, C.
Bonsall, C. D.
Callahan, J. P.
Carington, R. W.
Carney, J. A.
Casgrain, G. D.
Connelly, W. L.
Dodd, T. L.
Evans, W. H.
Fallen, Geo.
Flavin, J. T.
Fogg, J. W.
Fugate, F. L.
Gardner, J. E.
Goodnow, T. H.
Hall, W. B.
Harper, F. A.
Hiland, F. S.
Hincher, W. W.
Huber, H. A.
Jennings, D. F.
Jones, L. E.
Kinzman, C. C.
Kucher, T. N.
Kuhns, J. C.
Kuhns, J. H.
Lammedee, J. M.
LaRue, H.
Lodge, F. S.
Lucas, A. N.
Lundehn, Otto
McAlpine, A. R.
McClain, H. O.
McNeill, A. L.
Mann, H. S.
Metzger, M. A.
Midgley, S. W.
Miller, F. W.
Moler, A. L.
Monroe, M. S.
Montgomery, Hugh
Morehead, L. B.
Motherwell, J. W.
Naylor, N. C.
Olmstead, C. J.
Robb, J. M.
Rodger, J. H.
Rowley, S. T.
Schwarz, M.
Sharp, W. E.
Sisson, V. E.
Squire, W. C.
State, R. E.
Sternberg, A. S.
Stocks, W. H.
Strubel, C. H.
Symons, W. E.
Taylor, C. A.
Taylor, J. W.
Toohey, M.
Van Dorn, W. T.
Whipple, F. G.
Wilcoxson, W. J.
Wright, W. V.

THE CHAIRMAN: Gentlemen, if you will come to order the first will be the approval of the minutes of last meeting. The secretary

has been unable to get those out as yet, but promises they are correct, and I believe we will pass them, trusting to him.

Next in order is the secretary's report.

NEW MEMBERS

Name, Occupation, Address	Proposed by
C. F. Dodson, Baldwin Loco. Wks., Chicago, Ill.	Chas. Riddell
W. H. Bentley, Standard Steel Wks., Chicago, Ill.	Chas. Riddell
J. E. Buckingham, Standard Steel Wks., Chicago, Ill.	Chas. Riddell
Harold N. Scott, Griffin Wheel Co., Chicago, Ill.	C. F. Kopf
I. M. Ortmann, Griffin Wheel Co., Chicago, Ill.	C. F. Kopf
E. E. Chapman, Asst. to Engr. Tests, A. T. & S. F. Ry., Topeka, Kan.	R. W. Hunt
M. Stuart Plumley, The Linde Air Products Co., East Chicago, Ind.	M. Doran
J. R. Jackson, Asst. in Test Dept. A. T. & S. F. Ry., Topeka, Kan.	R. W. Hunt
M. P. Frutchey, Mgr. Ingersoll Rand Co. of Ill., Chicago, Ill.	R. W. Rusterholz
M. F. Cox, M. E., L. & N. R. R., Louisville, Ky.	R. W. Rusterholz
A. L. McNeill, A. P. A., C. & A. R. R., Chicago, Ill.	W. B. Hall
R. P. Noble, Westinghouse A. B. Co., Chicago, Ill.	C. J. Olmstead
Geo. W. Bender, Burton W. Mudge & Co., Chicago, Ill.	Herbert Green

MEMBERSHIP

Membership, October	1,581
New members approved by Board of Directors	13
Total membership	1,594

The Chairman: The list of new members has been presented to the board of directors and acted upon in the usual manner. That brings us up to the paper of the evening, the Use of Denatured Alcohol in Railway Service, by Mr. Michael Schwarz. Mr. Schwarz will you kindly come forward.

USE OF DENATURED ALCOHOL IN RAILWAY SERVICE.

By Mr. Michael Schwarz.

The object of this paper is to call your attention to the many ways in which denatured alcohol can be used in railway service, and it will be my effort to point out as briefly as possible in justice to the subject, some of the points to be gained by substituting denatured alcohol for other fuels now in use for certain purposes. But first of all it might be well to go briefly into the history of denatured alcohol.

Alcohol has been used in Europe to a great extent for the last twenty-five or thirty years. Especially in Germany it has been used with remarkable success for lighting, heating and cooking purposes, and in some instances for driving motors. Our government

being encouraged by the successful use of alcohol in foreign countries, Congress passed a law removing the tax from denatured alcohol, amounting to $2.08 on each gallon.

Denatured alcohol is distinctly a product of agriculture. It may be distilled from corn, potatoes and other farm products. It is therefore the ordinary alcohol of commerce to which the word denatured is applied to signify that its nature has been changed, and rendered rather undrinkable.

While the extent to which denatured alcohol will be used in this country cannot be safely judged from the progress of the industry in other countries, some facts may indicate what is possible under present regulations. England has had denatured alcohol since 1855; but it is not an agricultural country, and therefore much of her alcohol has been imported. In Germany, an agricultural country, where the conditions most closely resemble those in the United States, and where the use of denatured alcohol has been increased from 3,600,000 gallons in 1887, to 26,000,000 gallons in 1904, or over seven times in fourteen years.

Mr. C. J. Zintheo, of the United States Department of Agriculture, finds: "Special documents showing that in the United States alcohol was used for lighting, cooking and industrial purposes in the early sixties, and that prior to 1861 the manufacture of spirits was free from all special taxes and supervision, as much on the part of the Union as on the part of the States which compose it. It resulted from this freedom that alcohol served a multitude of industrial uses. The production was enormous, amounting to 90,000,000 gallons annually, from the distillation of corn. Large quantities being used at that date for lighting purposes. In 1864 the city of Cincinnati alone used twelve thousand bushels of corn per day for distillation, and because of its low price, alcohol was used as fuel for the domestic kitchen and laundry. The establishment and successive increases of the tax on spirits had the result of changing all these industries and in some cases of destroying them."

Alcohol lighting of Waiting Rooms of Railroad Stations. For years the question of properly lighting railroad stations, not only the country flag station, but the waiting rooms in good sized towns and small cities as well, has been a serious one for the companies. Of all the dark, dreary, shadowy, "spooky" places in the universe, the average waiting room of the country station at night stands preeminent. This feeling of darkness and gloominess on the passenger's part is, of course, intensified by his irritability of "waiting," even though the train appears on scheduled time.

In the past it has been almost impossible to find a suitable fuel for illuminating these out-of-the-way places. Electricity and gas are out of the question in the country districts and villages, and even in the towns and smaller cities the railroad stations are fre-

quently so far removed from the other sections of the town, that the lines do not reach them. So the only recourse was the kerosene lamp.

There is something about a kerosene lamp around a railroad station that arouses the ire of the traveler the moment he approaches. It may not be the lamp's fault, entirely. Station agents, as a rule, do not take kindly to cleaning chimneys and trimming wicks and filling the lamps from a greasy oil can, and so they neglect the lamp. Night after night the chimney gets a little more grimy, the wick a little more crisp, the supply of fuel a little lower and the light a little more feeble. No, it is not the fault of the kerosene lamp entirely, for, like Topsy, it was "made dat way." It can't be blamed for requiring so much attention. It is doing the best it can; but in the case of a Public Waiting Room, the best a kerosene lamp can do is not good enough, and a number of years ago the Germans discovered the many advantages of denatured alcohol as a lighting fuel. A burner was patented which generates gas as the alcohol is fed into it from the lamp fount. The ordinary gas flame gives a light equal to ten candles, more or less. By using a mantle, the actual light is increased four or five times, and its quality, steadiness and color greatly improved. Thus one alcohol lamp produces a light of 45.2 candle power, the equivalent to four or five gas jets, or three ordinary incandescent electric lights.

The Americans readily perceived the advantages of denatured alcohol, but the tax of $2.08 a gallon imposed by the Government made its use practically prohibitive. Recently, however, this tax has been removed, and Pyro or denatured alcohol is sold to-day at popular prices; or, in other words, it is cheaper to-day to burn denatured alcohol than to burn kerosene, in proportion to the amount of light used (in candle power).

But the greatest advantage of the alcohol lamp, particularly in a railroad station, is that it takes care of itself. The station agent can neglect it all he sees fit, but, like a twinkling star, it will wink back at him, and keep on burning just as brightly as ever. All it asks is that the fount be kept filled, an operation requiring about a minute's work. True the lamp has a wick, which feeds the fuel to the burner, but it never comes in contact with the flame, and therefore requires no trimming. Alcohol is absolutely smokeless and the lamp chimneys will continue clean week after week. Mantles used for twelve hours every night, frequently last for six months, so that the only attention the lamp requires in all that time is the refllling.

Most of us know how familiar is the odor of the kerosene lamp! The atmosphere of the railway station reeks with it as the fuel oozes from the fount, and the smoke ascends from the chimney. Pyro, in addition to being smokeless, is as odorless as an electric

bulb. And somewhere about the station, usually in a conspicuous place, is the well-known oil can. A great, greasy circle on the floor gives mute testimony of its whereabouts, and the fumes that arise add their corroborative evidence. There's nothing like that from the alcohol can. Alcohol does not ooze out, and if it did, it would evaporate. If, by chance, any is spilled upon the floor, it merely disappears. If spilled upon the finest fabric, it cleanses.

Not alone inside the waiting room, but in front of the station the alcohol lamp does yeoman service. A specially constructed lamp, with inverted mantle, gives a strong, steady white glow of 65 candle-power. Neither wind nor rain nor storm affects it, and it requires absolutely no attention except that the fount be kept filled. The regulation arc light is also made, which is particularly adapted for railway stations and used extensively for that purpose in Germany. The smaller ones give a light of 150 candle-power, while the larger ones have a brilliancy of 300 candle-power.

Possibly one of the most interesting features of denatured alcohol is the lighting system. And it is worth while to mention in passing that Kaiser Wilhelm's palace is lit with denatured alcohol lamps; also piazzas, hospitals and railway stations, and on some of the important streets in the German capital city denatured alcohol is very extensively used for lighting purposes, and has many advantages. If used in a closed room it consumes only a small portion of the oxygen that the same power kerosene lamp does. It is absolutely smokeless and odorless, besides being antiseptic.

The relative economy of denatured alcohol for illuminating purposes is clearly established by the official report of the Electrical Testing Laboratories of New York City, the recognized authorities in the United States for testing the candle power and rate of consumption of all kinds of lighting apparatus.

This report sets forth in detail the results of a test to determine the candle power and rate of fuel consumption of our household incandescent-mantle alcohol lamp-burner and a round-wick center-draught kerosene lamp (widely advertised as the most efficient and economical lamp on the market). The following is a summary of the official report of the Electrical Testing Laboratories:

Description	1 Gal. will last	Av. Candle Power	Candle Power Hrs.
Alcohol Burner	38 hrs., 30 min.	45.2	1740
Kerosene Lamp	32 hrs., 42 min.	14.8	484

The candle power hours are obtained by multiplying the average candle power by the time required to consume one gallon. Thus,

for illustration, the candle power hours obtained from one gallon of denatured alcohol were 1740, which means that if the alcohol burner had been one candle power capacity, one gallon of denatured alcohol would have burned for 1740 hours.

Since only 484 candle powers of light were obtained from one gallon of kerosene, it is manifest that over three and one-half times as much light may be obtained from one gallon of denatured alcohol as from one gallon of kerosene.

Therefore, for lighting purposes:

One gallon of alcohol at 60 cents a gallon, is as cheap as kerosene at 18 cents a gallon.

One gallon of alcohol at 55 cents a gallon, is as cheap as kerosene at 16 cents a gallon.

One gallon of alcohol at 50 cents a gallon, is as cheap as kerosene at 15 cents a gallon.

One gallon of alcohol at 45 cents a gallon, is as cheap as kerosene at 13 cents a gallon.

The cost to operate the household denatured alcohol lamp burner No. 201, which, as certified to by the Electrical Testing Laboratories, yields 45.2 candle powers of light and consumes one gallon of denatured alcohol in 38½ hours, would be:

Alcohol at 60 cents a gallon would cost less than 1 6/10 cents per hour.

Alcohol at 55 cents a gallon would cost less than 1 ½ cents per hour.

Alcohol at 50 cents a gallon would cost less than 1 3/10 cents per hour.

Alcohol at 45 cents a gallon would cost less than 1 2/10 cents per hour.

Denatured Alcohol used for cooking:

Denatured Alcohol has been styled the Twentieth Century fuel, and deservedly so. Its uses are almost unlimited, and while for lighting it stands without a peer, it is just as valuable for cooking.

One of the reasons why our American manufacturers have not made greater progress and met with larger success in the manufacture of devices to burn denatured alcohol is first that it required some study and careful investigation, in order to make the different devices that burn denatured alcohol economically. But to-day our leading manufacturers are building alcohol stoves, chafing dishes, percolators and lamps, with the result that the output of denatured alcohol is increasing very rapidly every year.

It is worth while to mention the fact that there has been considerable progress made in cooking with alcohol in the last few years. Many thousands of stoves have been sold, most of them for domestic purposes, and some for marine use. The stove is

built on the type of the ordinary gas hot plates, with one, two or three burners. In fact, it can be made in any form required, and take the place of any other cooking range. It certainly eliminates all the trouble that a coal stove gives to a house-wife on a hot day. The expense to operate these stoves is very small; efficiency considered, the cost is not greater than other fuels. Recently the Pullman Company have adopted and use denatured alcohol stoves in their broiler and buffet cars, and they are making quite a success of them. The writer has, on many occasions, investigated the efficiency of these stoves and find invariably that the alcohol stove is considered superior to the gas stoves, which they had previously used. Leading concerns at the present time are selling cooking appliances, using denatured alcohol as fuel, and they are experimenting with the alcohol devices, and it is a matter of but a short time when alcohol will be used generally in the railroad cars, for the reason that it is more efficient and affords a greater element of safety. The reservoir tanks can be recharged at any Terminal, and it is easier to obtain alcohol than gas.

Denatured alcohol for heating refrigerator cars for the protection of perishable freight during the winter weather.

There is a growing demand which is being felt by all the railroads for a heated freight car for the protection of perishable products during the extreme winter weather, and there are a number of stoves on the market, burning different kinds of fuel, and which are being used for the purpose of heating freight cars. But in answer to a general demand to meet the requirements of the railroads, that is, to furnish a heater that will operate automatically and without requiring an attendant to go with each car or train;

Second, to furnish a heater that will burn continuously for a period of a week or more without attention;

Third, to furnish a heater that is automatically regulated by a thermostatic instrument, and,

Fourth, a heater burning a fuel where the products of combustion can be used as a heating agent, without any liability of damage to the most delicate eatable products by smoke, smell or soot, and with an idea of the greatest factor of safety, where the liability for explosions is eliminated, and the fire risk reduced to the lowest possible minimum.

Such portable heaters are now on the market, using denatured alcohol. They have been in test, in actual service, for more than a year; have been examined and approved by a number of railroad officials.

This heater is used as a gravity feed burner. Wicks and hand manipulated valves are entirely eliminated. They are regulated automatically, and will burn for a period of ten days without

attention, as the burning of denatured alcohol does not require the admission of any free air into the car to support combustion, as the air is not vitiated to any appreciable extent, and the products of combustion are used as a heating agent. It does produce antiseptic conditions. There is no smoke or soot, therefore it seems to be the ideal fuel to use in the cars for the protection of eatable products.

This heater is made in two sizes, single and double burners, and can be applied to any car by setting it on the floor at the door, or by placing it in the ice box at the end of refrigerator cars.

One more important feature of denatured alcohol is its use in automobile radiators in the winter time. By the use of a small proportion of alcohol in the radiator, automobiles may be safely run through the winter, regardless of atmospheric conditions, but two things are important in the selection of a non-freezing solution—first, the action of the solution upon the circulating system, and secondly, the ability of the solution to withstand high and low temperatures.

Denatured alcohol contains everything desired for a non-freezing solution, and is absolutely lacking in all of the objectionable features. Apply it to any metal and no corrosive action appears. It is an ordinary ethyl alcohol of commerce made unfit for drinking, but does not throw off any foul odors. Its ability to withstand cold is indicated by the fact that it freezes at about 160° below zero, Fahr. Manufactured in accordance with a formula prescribed by and under the direction of the United States Government, its composition is made uniform. No filtering is necessary, as it contains no solid matter which, in other solutions frequently clogs the radiator. It is mixable with water in all proportions.

Denatured alcohol is inexpensive and should be procurable at all first-class garages, druggists, grocers, hardware dealers, department stores, etc. By its use you are insured against freezing, against cracked cylinders, leaking radiators and damaged pumps. Through snow and slush, with the temperature down to any point recorded in the United States, your machine runs on. No heated garage is necessary and blankets and other covering for the radiator may be numbered among the useless precautions of the past. Your car can stand all day and start off instantly when needed.

Mr. Schwarz: Mr. Chairman and Gentlemen of the Club: I consider it a great honor to present this paper to you. I am sorry that I have not had more time to properly prepare it. If there are any questions you would like to ask I shall be glad to answer them. (Applause.)

The Chairman: Gentlemen, you have heard the reading of Mr. Schwarz' paper and I trust there will be a free and voluntary discussion on it, without calling individually on the members. The paper is open for discussion.

Mr. W. C. Squire: I have a few questions I would like to ask Mr. Schwarz: You state in the body of the paper that the chimney of lamps burning denatured alcohol do not become foul. Why is this the case? You take for instance the ordinary gas burner equipped with a mantle and chimney and there is always a deposit supposedly of sulphur on the chimneys, which makes them somewhat opaque, similar to the effect caused by sand blasting. I do not know whether that deposit comes from the dust in the air or whether it is in the gas itself, but in my opinion it is probably due to the sulphur in the gas. We see the same thing occurring when gasoline gas is used under the same conditions and very often an oil burning lamp chimney becomes laden with moisture and a deposit of the water from the products of combustion which is dried off suddenly by the heat of the oil flame, and there is left as a deposit a material similar to the dust usually found in the atmosphere. I presume that this same deposit would occur in an alcohol lamp provided with a chimney. Another point made by the author is that the amount of air required to burn alcohol is much less than is required for any other fuel. I would like to have Mr. Schwarz advised us as to the relative amount of air required to burn, say a pound of alcohol as compared with a pound of gasoline or any other liquid fuel. I realize that the difference in the amount of air required to give complete combustion varies with the number of heat units contained in the fuel itself.

It will be interesting to have a fuller and more explicit explanation of the reason why the products of combustion from alcohol are less objectional to food products than that given off by other liquid fuels.

The Chairman: Would you like to answer the questions as they are asked, or would you rather wait until the end and answer them as a whole?

Mr. Schwarz: Mr. Chairman, I will answer them as a whole.

Mr. W. B. Hall: We have with us tonight Dr. R. E. Humphreys of the chemical laboratory of the Standard Oil Company. Perhaps he would be glad to say something.

The Chairman: We would be glad to hear from Dr. Humphreys.

Dr. R. E. Humphreys: Mr. Chairman and Gentlemen of the Club: I have been requested to attend the meeting of this club by the Big Chief of the Kingdom of Gasoline to learn of any attack contemplated upon his provinces. He is always upon the alert for any spirit that might endanger his honored and justly celebrated articles of commerce. We of the late esteemed Standard Oil Company have always looked upon alcohol most benevolently

and complacently. As long as it is kept to its proper field as we consider it (laughter) the cocktail, highball, and other such extremely cheering fluids, we were delighted to associate with it, even in a most intimate way (laughter), but when it began to encroach upon our particular but now most limited field that the Supreme Court has marked out for us, and that we are trying the best we can in our poor, weak way to hold, we are inclined to be annoyed, and even to resent such encroachment.

I consider myself fortunate to have the acquaintance of the speaker of the evening, and I very greatly enjoyed hearing his address, but I am forced by hard facts in this case to take exceptions to some of his contentions. He referred very feelingly to the poor illuminating quality of the light given by the kerosene lamp in the railway station. I think he is a little unjust in ascribing to the kerosene oil itself the feeble light found in these station lamps. Kerosene oil is one of the best servants man ever had, and it will stand more abuse, and do more good service under the most villainous care than any other substance with which I am acquainted; and I am really surprised when going into some of these railway stations and beholding the utter neglect that has been given to these poor old kerosene lamps to see that they are giving any light at all. Let us examine one of these lamps. The burner has neither been cleaned nor renewed since the building of the station; and its wick is clogged with carbon and its air inlets stuffed with lint and dust, so that the very breath of its life is shut out. The wick, instead of being renewed every two weeks, has been allowed to remain in use until it became too short to reach the oil, and the station agent has endeavored to extend its life to the last fraction by attaching to it a red strip of one of his old worn-out socks (laughter). I have frequently given such an outraged old kerosene comrade a sorrowful pat on the back and asked him if he would not like to get out of his dirty old prison and into a bright, new temple of light.

Now you know that the use of kerosene oil has had honorable praises bestowed upon it for years, far beyond the remembrance of even the oldest of us who are present tonight. My childhood evenings were made glad by the mellow light of its cheerful effulgence. Under its stimulus I toiled over my student labors until the midnight hours. In countless cases it has taken up the educative work where the Lincoln pine torch left off, and has thus assisted in working out the destinies of great men. It is known not only throughout the length and breadth of this land but also of the entire world. My wife is a great missionary society enthusiast, and every returned missionary she can find in her neighborhood she brings to our home, and, of course, being interested in the Standard Oil Company, she encourages these missionaries to tell us about the use of Standard Oil Products out in the middle of Africa and in the fastnesses of China. We have been told how the

Standard Oil products are civilizing those benighted countries. Those peoples not only use the oil for light and warmth and cheer, but they employ the cans in which the oil is shipped to cover their houses (laughter), and the corks to fashion into household gods (laughter), and we are told that they even dissolve off the labels and use the fine quality of glue we put them on with to make a delicious soup (laughter), much preferred to rat-tail soup (laughter).

Kerosene oil has done magnificent service in lamps everywhere for many years, and will continue to do so long after our little day has been spent, and we have been laid away in our little, narrow homes under the light of the stars.

Now, the speaker gave a comparison between the light of a kerosene lamp and that of an alcohol lamp that I desire to call your attention to for a few moments. He uses the alcohol lamp with the incandescent mantle and compares that with the ordinary kerosene flame. I don't know whether it is known to the speaker or not but it is very well known that the Standard Oil Company has invented a method of using kerosene oil with a gas mantle, and it makes a fine light, and I think that if the light of the incandescent mantle alcohol burner has been compared with the light of the incandescent mantle kerosene burner there would have been found no difference in the candle power, so that the figures he gives are somewhat misleading in that respect.

Now, not to hold your attention too long, I will give you a few figures on the comparative use of kerosene oil and alcohol for heating purposes.

It is well known that when our government passed the law concerning denatured alcohol, great claims were made about the cost of such alcohol. It was going to be reduced to 13 or 14 cents a gallon and the Standard Oil Company was scared stiff for a little while, until it investigated and found out that it would be impossible in this country to produce denatured alcohol at less than 45 cents a gallon and then it breathed easier and has not been very much afraid since.

I hastily made a few figures before I came here, and found the thermal efficiency of alcohol to be 12931 B. T. U's per pound. Crude petroleum is 19800 per pound. Alcohol and petroleum weigh very nearly the same number of pounds per gallon, and kerosene as used in these heating appliances weighs 6:78 lbs. per gallon, so that a gallon of alcohol gives 85603 B. T. U's, while a gallon of kerosene will give 134234 B. T. U's per gallon, nearly twice as much.

While a gallon of alcohol costs 45 cents, a gallon of kerosene if bought from the Standard Oil Company direct will cost you five cents. So you see the enormous difference there is between alcohol and kerosene, and no quality that alcohol may possess will compensate for that difference in price and heating power. In the use

of an incandescent mantle the incandescence is produced by the heat, so you can readily see that the material that produces the greatest heating power is going to give you the greatest candle power also.

Now in any appliance where heat is required there can never be any competition between alcohol and kerosene as long as the prices remain anywhere near where they are at present.

The speaker referred to a special adaptation of alcohol, that is for heating cars, the heating of freight cars.. Kerosene heaters have been well adapted for this purpose. The Mather Stock Car Company makes a most admirable apparatus for this purpose. I might describe this heating appliance to you to some extent so you may get an idea of how it works. The heating chamber is placed underneath the car and regulation kerosene oil heaters are placed in this. A reservoir of kerosene oil is placed entirely outside of this and away from it, a sufficient distance to procure the proper safety, and then there is an arrangement for keeping the level of the oil in the burners the same all the time. Between these burners and the bottom of the car there is a galvanized sheet iron plate to shut off all possibility of combustion from the car. Above this are heating flues or ducts that simply carry the radiated heat throughout the cars. These ducts are arranged beneath the floor of the car and there are certain holes throughout the car where by this arrangement pure heat is brought into the car. So you see when the car is heated by this radiation none of the products of the burners can reach the contents of the car and it doesn't make any difference how delicate the food products are that are being transported, they cannot in any way be injured. The chamber beneath the car is so protected by asbestos sheets that there is no danger whatever of fire, even in an accident.

For cooking purposes there cannot be any appliance for using alcohol that has any advantages over the cook stoves that are produced at the present time for kerosene oil. The economy in the use of kerosene oil over the use of alcohol is so great that I do not believe that alcohol will ever be able to displace it.

I think I have said enough for kerosene tonight. I feel if you will think over these matters you cannot but agree with me in respect to these things that I have said. I am very glad to have had the opportunity of speaking to you tonight and I thank you for your great courtesy. (Applause.)

Mr. W. E. Sharp: We all felt timid about speaking on this subject, until Dr. Humphreys has so kindly taken the initiative and acknowledged our allegiance to alcohol in its various forms. I don't think there is any need now for me to be quiet any longer. Both of the previous speakers have illuminated the subject to some considerable extent and some one over in the corner has suggested, that the late ruling of the Supreme Court has also added considerably more light to this subject.

I will have to acknowledge that I don't know as much about alcohol in its various forms as some of you, or as I may know in the future, but speaking from a mechanical viewpoint on the subject of the paper I have had considerable experience in the last few years with denatured alcohol and that is the form of alcohol we are talking about tonight.

About three years ago in my humble position I was asked to produce some kind of a heater to answer the growing demand that was being made upon the railroads for heater car service, and we decided first on kerosene oil, because it was the best known fuel and we knew more about it at that time and because it was the easiest obtainable at all points. However, we soon discovered that kerosene oil would not answer for the service for which we wanted it. We did not discard that, however, until after we had spent considerable time and money and until after we had called to our assistance the experts of the Standard Oil Company, and after several special stoves had been tested.

After that we tried various gases; in fact tried everything that we knew about that would burn, and when we were ready almost to believe that we would not be able to find the fuel that would meet the requirements for heating eatable products as we understood them, we decided to use denatured alcohol. We obtained from the Government all of the information they could furnish in regard to the use of denatured alcohol; we consulted a chemist of experience, who was for many years in the laboratories of the Government, and who wrote the present specifications for denatured alcohol. I refer to Dr. Charles Crampton. We further sought assistance from the Universities, and we finally discovered that denatured alcohol was the ideal heating agent for heating cars wherein delicate eatable products were contained.

It was necessary, however, to find a burner that would regulate automatically the fuel supply, so that it would not require an attendant to go with the cars. It must also automatically shut off the fuel supply entirely in case the fires were extinguished. All these operations without the use of manually operated valves. It was necessary for it to burn continuously throughout the trip from loading point to destination without attention, and it is needless to say there was no such burner on the market. After considerable time we finally developed a burner that meets all of these requirements, and has passed favorably before the Bureau for the Safety of Transportation of Explosives; has been tested and approved by several railroad representatives, and is now being satisfactorily used in a large number of our cars handling perishable products through a temperature as low as 45 degrees below zero. We have had these burners in test as long as 15 days without attention, but the average service trip last winter was eight days, and the burners worked perfectly.

I am not able to discuss in technical terms with Dr. Humphreys, the thermal temperatures, or theoretically along that line, but when you come to put it into practical service tests in a freight car, I know something about the results from my experience; also that denatured alcohol at 38 cents per gallon as a heating agent is on a par with kerosene at present market prices, for the reason that where there is no supply of free air necessary to support the combustion you create an antiseptic condition. The products of combustion being used as a heating agent further reduce the cost of fuel. A chemist of international fame said to me within a few weeks that it was highly desirable and he believed it would produce what might be termed a preserving condition, and I told him we were in the heating business and not in the preserving business.

In my experience burning kerosene I had to supply about 30 per cent of free air to support combustion. Reduced to brass tacks, that represented a 12 inch opening in the bottom of the car to supply the necessary air for kerosene burner, and with alcohol we don't have to supply free air; the air in the car at the time fires are lighted and radiation is sufficient; consequently you can understand that an opening of 12 inches in diameter when the thermometer registers 45 degrees below zero is admitting considerable cold air that you have got to heat. Perhaps some of us who were raised in the wilds of Indiana remember the country school house, and when an 8 by 10 window pane was broken out of the window how much cold air could come in.

I don't know what all can be done with denatured alcohol. It it in its infancy, so to speak. I have only been dealing with it two years, and I have found so many adaptations where it will meet the requirements so admirably in every one of these adaptations that it seems to me to be an ideal fuel if you want a high grade fuel for heating, lighting and cooking.

One of the previous speakers mentioned the light and the effect on the chimney, collecting of moisture, dust, etc. I arranged a lamp with which to make a test for lighting. On the 9th day of December last year I put that lamp in operation. It has been used every night since, burning it in my library, I should say an average of two and a half to three hours every evening. The chimney has not been cleaned and I am still using the original mantle. Now don't smile and think that my library lamp is dirty—it is not. I am burning this as a test and it is giving plenty of good light at the present time.

Mr. Squire: I would like to secure some definite information from Dr. Humphreys regarding the actual number of heat units contained in a gallon of "petroleum." Is there any difference in the "petroleum he has just spoken of and the kerosene we ordinarily use? I understand that in kerosene there are only 13,600 B. T. U's, and that in "petroleum" or crude oil there are 19,000 B. T. U's. I

understand further that a "distilled oil" such as kerosene or gasoline has much less heat value per pound than the so-called "fuel oils" or "crude oils" sold on the market for use in furnaces.

Dr. Humphrey: I spoke of the ordinary kerosene, ordinary burning oil, as we term it. Now of course there is some difference in the fuel oils that are used in furnaces and in the crude oils, as regards thermal efficiency. Crude oils usually run up to about 21,000 but I have never known any of our ordinary oils that were used for any purposes of heating that went as low in thermal efficiency as the figures you suggest. The figures that I have here are taken from the United States Geological Bulletin 392, where over 2,000 tests between alcohol and kerosene are recorded, and the average of these tests is 19,800, giving per gallon of kerosene, as I said before, 134,234 B. T. U's.

Mr. Squire: Does that actually check up with your own figures?

Dr. Humphreys: Yes.

Mr. Squire: Figures that I have been able to get in reference to the B. T. U's in distilled oil are certainly much below what you have just stated, and I do know that I do get higher heating efficiency from the commercial crude or fuel oils than I do from the kerosene, by actual results in service. This question is raised simply to get at the facts so that we can make an actual comparison between kerosene oil or petroleum distillate and denatured alcohol, as to their relative thermal efficiencies. From the "crude oils," such as are purchased in the open market from distributing companies my understanding has been that they do not contain the same B. T. U's as are found in the oil such as is taken direct from the wells. Are we to understand that all the commercial fuel and burning oils which we can buy today do not give us more than 19,719 B. T. U's?

Dr. Humphrey: As I understand you, you are speaking now of kerosene, ordinary lamp oil, is that it?

Mr. Squire: I am trying to find out how you get ordinary kerosene, water white, 153 degree test, 19,800 when all the other figures that I have been able to get hold of don't give us but 19,719.

Dr. Humphrey: I have two authorities here and I will be pleased after adjournment to show you the figures as given there.

Mr. Squire: Simply a matter on which to base the fact.

Dr. Humphrey: Our tests in the laboratory all give between 19,000 and 20,000 for ordinary kerosene oils at 42° Be.

The Chairman: Is there anyone else who has anything to say on this subject? I believe that Mr. Montgomery, Supt. Motive Power of the Bangor & Aroostock R. R., is with us this evening, and I am sure the members will be glad to hear from him on this, if he has anything to say.

Mr. H. Montgomery: We are obtaining very good results from the use of alcohol in heating cars, but more than that I know very little about the heating qualities of denatured alcohol.

The Chairman: Mr. Symons, we would like to hear from you on this subject.

Mr. Symons: Mr. Chairman and Gentlemen: I disclaim any knowledge on this question of alcohols in general, but there are one or two thoughts in connection with the use of denatured alcohol on which I would like to have a little information if the author will kindly refer to it in his closure.

As I understand it, denatured alcohol is rendered rather undrinkable by the acids of benzine or other liquid preparations which cannot be used as a beverage. I am awful glad the author has thus described it as being "rather undrinkable" rather than making it positively unfit for drinking purposes. While this feature has no special interest for myself, yet I fancy it might be of some comfort to some people if they used this in the radiator or their automobile and were on a long trip where it was impossible to reach a place of liquid refreshments, they might, in a case of emergency, take a few drinks out of the radiator until they could secure a more desirable or palatable beverage (laughter). Whether this would be possible or not, I would be glad if the author would give us a little information.

In Germany, as I understand it, the denatured alcohol is positively undrinkable on account of admixtures of the following elements: Camphor, Sulphur, Ether, Iodoform, Benzine, Castor Oil, Lye and various other things of that kind. One of the common forms used in the United States is to mix Wood Alcohol and a little Benzine with the regular alcohol of commerce, which is the product of sugars from various kinds of vegetables, cereals, herbs, etc.

The question of the use of denatured alcohol in cars for heating purposes, particularly where the question of the quantity of air for combustion is to be considered, is one, of course that is of interest to all those who have anything to do with heating cars that handle perishable goods, and while the kerosene lamps have rendered good service, and are according to the best authorities on the subject still giving good service, yet the quantity of free air necessary for combustion is quite a factor and must be reckoned with in the selection of a fuel or device for car heating, for the system or arrangement that requires a less quantity of free air will be, of course, the most easily heated and less subject to variation in temperatures.

The question of fires in the car from heating apparatus in case of a wreck, is one on which there would not be much of a talking point, as the danger coming from that source would probably be about equal in either case.

As for the use of denatured alcohol for domestic purposes in the household or for cooking or dining, café or private cars. anything that will lessen the cost and reduce the danger of explosion of fire will, of course, be considered as a material improvement,

and will find a ready field for application although the present devices in use are as a rule very efficient, and when taken care of present a very slight element of danger. The odors from kerosene, particularly from leaking lamps, oil cans, etc., are, of course, very undesirable, but as it has been properly pointed out by Dr. Humphreys, this is not the fault of the kerosene, but rather the fault of the people who handle it, or in other words, the people who fail to handle it properly, and as the doctor has well said, kerosene should not be blamed for the faults of careless people.

The speaker has not only given us a very intelligent outline of the present use of denatured alcohol, also the possibility of its future use, but has drawn from Dr. Humphreys a reply which is of special interest and has conveyed much valuable information with reference to the merits of kerosene and gasoline.

Denatured alcohol being a product of sugars, and kerosene a product of petroleum or mineral oil, it would seem there was an excellent field for meeting the increased demand for fuels of both characters, from the two different sources mentioned, and that a large field for the use of denatured alcohol can be well covered without in any manner encroaching upon the present market supplied by the Standard Oil Company's products. In other words, the additional uses for which fuels of this kind are being required. has created a demand for such an additional quantity than was formerly used, that if the denatured oil products even supplied a small portion of this additional demand, it would in itself afford a very large market, so that I am inclined to the belief that the intelligent discussion of subjects of this kind by such persons as the author of the paper of the evening, and Dr. Humphreys who has so very ably presented the Standard Oil Co.'s side of the question, is in the form of missionary work right here in our own country, which will result in an increased demand both for kerosene, gasoline and denatured alcohol, the final result being that there will be an additional demand in both fields that will result advantageously to the manufacturers of both kinds of liquid fuel, and, of course, indirectly result in using a less quantity of various kinds of solid fuels, such as bituminous, semi-bituminous and anthracite coals, coke, wood, etc. This will to a certain extent assist in the conservation of our present natural resources and will add to the volume of business now handled by the dealers in various kinds of mineral oils and its by-products and particularly denatured alcohol, which is a product of agriculture.

Aside from the commercial aspects just mentioned, the discussions are both interesting and valuable and will add considerable to our present knowledge on the subject.

The Chairman: I believe that Mr. F. S. Lodge is in the room, and if he is, the Club would be glad to hear from him anything he has to say on the subject.

Mr. F. S. Lodge: At the time a good many of the earlier tests that Mr. Sharp mentioned were carried on, I was associated with Mr. Sharp and went through with a good many of the trials personally that he mentioned. Along the lines that Mr. Symons spoke about the possibilities of denatured alcohol as a beverage I have not had much personal experience, but I have had a little observation, not only using alcohol in automobile radiators but I have seen a laborer take nearly a quart of denatured alcohol and drink it straight and he isn't dead yet, so that I think that the dilution that is usually used in automobile radiators would be perfectly safe.

Another question that Dr. Humphreys brought up—I don't remember the name of the car: none of the products of combustion of kerosene were allowed to enter into the car,—I think most of the gentlemen here are familiar with the low efficiency that is usually obtained in boilers burning coal where the gases of combustion come in contact, in either firetube or watertube boilers with a heating surface. There only a comparatively small proportion of the heat units are actually used—the heat goes up the stack. In using kerosene with a flue, in not allowing that heat to go up into the car you see that you have the same proposition that you have in burning coal under a boiler. That condition alone if seriously considered will make up the difference in the B. T. U's in the use of denatured alcohol and kerosene.

I want to bear out Dr. Humphreys' statement concerning water white kerosene, the B. T. U's will run in the neighborhood of 19000 if carefully tested.

The Chairman: Gentlemen, I wish you would voluntarily get up and tell us what you know about this subject and not wait to be called upon. Mr. Hall, can you tell us anything about the kerosene heater in the Mather car?

Mr. W. B. Hall: The subject of the paper I believe is alcohol. Personally I haven't had any experience with this ingredient. It is true we have developed a heater for heating cars in the shape of an oil burner that has proven very satisfactory and in the construction of the car we have prevented the disadvantages and the obnoxious features that have been mentioned here in connection with kerosene. Dr. Humphrey has explained in a general way what we have. Personally I have no data as to a comparison of the efficiency of alcohol and kerosene. Our device we find works very satisfactorily and is very inexpensive.

The Chairman: Mr. LaRue, have you anything to say on this subject?

Mr. H. La Rue: Unfortunately I haven't had much experience with either one of them. I have never been stewed with the one nor burned with the other; for that reason I haven't got anything to say.

The Chairman: Mr. Carney?

Mr. J. A. Carney: Mr. Chairman, I want to ask a question about the amount of air used by kerosene as compared with alcohol. The statement has been made that you have got to put an opening in your car in order to get sufficient air to burn your kerosene, whereas, with alcohol no opening is necessary and that it doesn't require any air to burn alcohol. Now, as a matter of fact, alcohol is composed of carbon and hydrogen and I believe that kerosene also is composed very largely of carbon and hydrogen and neither of them will burn without oxygen and therefore you need air. I don't know what the combustion of kerosene is, but I do know what the combustion of alcohol is.

But one thing was brought up this evening about the relative uses of kerosene and alcohol that is interesting to me. Years ago I was told that when a bunch of missionaries went out in foreign countries to the heathen they always carried a barrel of alcohol and now I am told that they take along some kerosene. I think the Standard Oil Company ought to be indorsed by the Women's Christian Temperance Union.

Mr. W. E. Sharp: Mr. Chairman, I am going to answer the question that Mr. Carney asked, as I was the one that made the statement. If I remember correctly, I did not say that it did not require air to support the flame burning alcohol, but I did make the statement that you did not have to supply any free air when burning alcohol. It follows that the air in the car and leaks and radiation will support combustion. My experiments were made with refrigerator cars built as tight as could be, the walls were insulated and built as tight as it is possible to build a refrigerator car, and we find that alcohol will burn in such a car indefinitely. In one of the tests we burned alcohol heaters for a period of 77 hours and then got into the car and stayed in there for three hours without feeling any bad effects from the breathing of that air in the car. I can't tell you what the chemical condition was, but you can draw your own conclusions. If the air had been very poisonous or low in oxygen we surely would have felt the effects of it.

Mr. Montgomery: I would like to say in regard to the tests of refrigerator cars burning alcohol that we had a great many heated cars, using both kerosene and alcohol. With the kerosene stoves there was an odor from the kerosene in the car, but in a test of 48 hours, bringing the temperature of the car up from 12 below zero to 40 above we had no trouble with the alcohol burners heating the car right up to that temperature and the air in the car was all right when we opened the car and there was no odor at all in the car. We have been using a great many of these alcohol heater cars and are using them now, and we are having no trouble whatever. The air in the car is all that we can desire.

The Chairman: Has anyone anything to say on the use of alcohol for purposes other than those specially mentioned in the paper, for shop use or anything of that kind?

Mr. Mann: Mr. Chairman, I would like to ask if anybody has had any experience with the use of alcohol in free heating? The reason I ask this question is that in some places gasoline is objected to for that purpose and I think that alcohol could be used. That is a use to which it could be applied without much danger or without much risk from explosion.

The Chairman: Is there anyone in the room who has made any experiments along the line that the last speaker has indicated?

Mr. F. H. Rodger (Safety Car Heating & Lighting Co.): (Communicated): I want to take issue with Mr. Schwarz, as to the superiority of denatured alcohol over Pintsch gas for broilers and gas stoves for use on railroad cars.

In the first place, the gas is more convenient and easier to handle. It is only necessary to open the cock to the burner and the flame is immediately burning at its maximum efficiency. The supply of gas fuel is much easier to obtain than a supply of alcohol. Practically every railroad terminal in the country has facilities by which gas can be supplied to cars, and this supply is always maintained without the necessity of attention from anyone connected with the car. If alcohol is to be used, it will be necessary to carry a supply at all terminals and it will be necessary for the person in charge of the car to see that the tanks are properly filled.

In regard to safety. I think it is generally admitted that a supply of gas stored in the proper tank under the car is safer than a supply of liquid fuel inside the car.

As regards the cost. A gallon of alcohol is equal to not more than 60 feet of Pintsch gas. Alcohol would cost, delivered on the car at least 60 cents a gallon, while the cost of the gas delivered to the car will only be 30 cents.

It would seem from this, that as regards convenience, safety and cost, the advantage is all with the Pintsch gas stove.

A Member: Mr. Chairman, I believe pretty nearly everybody here has denied all knowledge of the subject of the use of alcohol. I am reminded of a preacher down south who attended a camp meeting and preached on the sanctity of the home and finally he said: "I would like to know if there is a man in this audience who never spoke a cross word to his wife." Finally two fellows got up. He said, "Won't you come down to the platform." They came down to the platform and he turned to the audience, "Now," he said, "I want you to look at two of the biggest liars in this State."

The Chairman: If there is nothing further to be said on this I will ask Mr. Schwarz to close the paper of the evening, replying to the questions that have been asked. Will Mr. Schwarz come forward?

Mr. Michael Schwarz: Mr. Chairman, I have listened with great interest to Dr. R. E. Humphreys' criticisms on the uses of denatured alcohol.

The comparison of the efficiency of alcohol and kerosene has been made with the best known kerosene lamp and the alcohol lamp that is generally used in this country. I am aware of the fact that a kerosene mantle lamp is used in this country but my understanding is that this lamp had never been a success. After the lamp is lit for any period of time the burner gets hot and generates more kerosene vapor than can be consumed and some of the surplus carbon will be deposited on the mantle. It needs the continuous attention of some person, as the wick will have to be turned lower and lower in order that this lamp will burn with a perfect combustion. The wick has to be very well trimmed and the chimney cleaned, otherwise, you will not get sufficient light from this lamp. On the other hand, you take the alcohol lamp and after the burner is heated it requires absolutely no attention of any kind. It will burn, with one quart of alcohol, between nine and twelve hours, and, regardless of surroundings or weather conditions, the lamp cannot smoke. The mantle which is used on the lamp is specially constructed, made of a fibre preparation, and it gives approximately 20% more light than the ordinary cotton mantle will give. On several occasions alcohol lamps have been used where the mantles have lasted over eight months, with ordinary care.

In my paper I tried to point out the advantages of the use of alcohol lamps in railroad stations, especially in small places where only one man is employed, who will have to take care of everything. It will be a great relief to him to eliminate the amount of work and time wasted in the care of half a dozen or more kerosene lamps.

Dr. Humphreys made a comparison of the B. T. U's of alcohol and kerosene. It is very true that kerosene has higher B. T. U's than alcohol but the alcohol is used in a gas form with the Bunsen system and in this state its efficiency is increased about 38%.

While alcohol is more expensive than kerosene, in the long run there is very little difference in the cost of operation, which is more than counter-balanced by the many advantages of this newer fuel.

Regarding the heater cars, Mr. Sharp, who is present tonight, explained fully the construction and advantages of these cars. I have been associated with Mr. Sharp since he began experimenting with heater cars, and went to Maine with the first three cars. This afforded me the opportunity of seeing, in actual operation, both alcohol and kerosene heater cars. In my observations I learned that a kerosene heater car requires an attendant while an alcohol heater car will travel about twelve days without an attendant.

Regarding my previous remark that "denatured alcohol is RATHER undrinkable," which statement has been questioned, would say that it IS undrinkable. In explanation of this I beg to say that the paper had to be prepared on very short notice and I was unable to read same over and make necessary corrections.

Not being thoroughly familiar with the English language, this was merely a misuse of words, which I trust will be excused. In connection with this, perhaps it is worth while mentioning that some years ago, when I took up a course of Chemistry, one of my Professors called an old servant of the school into the lecture room. There he had on the table a glass of pure alcohol and a glass of denatured alcohol. He asked the man to drink both of them. He did so, and pointing to the empty denatured alcohol glass, said: "This is the real whiskey." The man lived for many years after I left the school and the chances are that he still enjoys good health, provided he has stopped the use of denatured alcohol as a beverage.

In Germany and in this country they are using various chemicals for denaturing purposes, but for commercial or household use we can only denaturize by using materials which comply with the government requirements. In this country the wood alcohol formula is used almost exclusively and the proportion in which this is mixed is to each 100 parts of Ethyl alcohol 10 parts of Methyl alcohol and ½ part of benzine. All other denaturing materials, such as camphor, sulphur, iodoform, benzine, castor oil, etc., can only be used in specially denatured alcohol, for manufacturing purposes only, and this alcohol never comes into the household, as it cannot be bought or sold by ordinary dealers.

The formula of the proportion in which alcohol and air mixes is as follows:

$C_2H_6O+6O=3H_2O+2CO_2$.

In the heater car where we use alcohol we need some air in order that it will burn, but the amount of air which is in the body of the car is enough to support perfect combustion. This has been proved by hundreds of tests that have been made in my presence with various refrigerator and heater cars.

Mr. Symons, in his talk, says that "all the advantages of alcohol which have been mentioned at this meeting will have to be proved in the future."

I would like to say, in this connection, that the facts mentioned here are based on results which have been obtained during the last twenty-five years in European countries, where alcohol has been used extensively, and the yearly increase in the output of denatured alcohol satisfies us that this fuel must be giving satisfactory results.

I want to thank you once more for giving me the opportunity of presenting this paper to you, and also for your kind attention and interest.

On motion, the meeting adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

Library, 390 Old Colony Bldg.

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The regular monthly meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, December 19, 1911, Vice President T. H. Goodnow in the chair. The meeting was called to order at 8:30 P. M. Of those present the following registered:

Beattys, W. H. Jr
Black, R. C.
Bourne, G. L.
Callahan, J. P.
Carlton, L. M.
Conrath, P. J.
Cota, A. J.
Dailey, E. B.
DeVoy, J. F.
Derby, W. A.
Dewey, L. R.
Ensign, H. W.
Farmer, F. B.
Fenn, F. D.
Fitzmorris, Jas.
Flavin, J. T.
Fugate, F. L.
Gill, Jno.
Goodnow, T. H.
Goodwin, G. S.
Hall, W. B.
Hodgins, E. W.
Hull, G. A.
Hyland, R. H.
Jordan, J. B.
Kennedy, J.
Kleifges, Geo.
Kucher, T. N.
Lammedee, J. M.
Langan, J. M.
LaRue, H.
Laughlin, G. F.
Lawrence, W. J.
Lovell, C. S.
Lundehn, Otto.
Mann, H. S.
Madsen, S.
McAlpine, A. R.
McClain, H. O.
McGinnis, C. P.
Midgley, S. W.
Miller, C. E.
Miller, E. A.
Monroe, M. S.
Morehead, L. B.
Morris, T. R.
Motherwell, J. W.
Naylor, N. C.
Neeley, P. J.
Olmstead, C. J.
Ortman, I. M.
Robb, J. M.
Rodger, J. H.
Rowley, S. T.
Sawyer, L. W.
Seeley, J. S.
Seidel, G. W.
Sinkler, Jos.
Summers, J. S. Jr.
State, R. E.
Sweringen, F. H.
Symons, W. E.
Thurnauer, G.
Tawse, J. G.
Taylor, C. O.
Ulery, L. M.
Wallace, W. G.
Walsh, W. J.
Wheeler, S. C.
Wiese, A. J.
Wilson, L. F.
Womeldorf, C. F.
Wright, A. B.
Wright, A. H.
Wright, C. P.
Wright, Wm.
Wymer, C. J.

The Chairman: Gentlemen, if you will come to order, we will proceed with the meeting. Unfortunately President Young and

Secretary Taylor are both out of the city tonight, and if you will kindly bear with those filling their places, we will appreciate it. The list of new members admitted is as follows:

NEW MEMBERS

Name Occupation Address Proposed by

C. R. Branson, N. P. Inspector, Penn. Lines, Ft. Wayne, Ind......J. R. Conick
E. B. DeVilbuss, N. P. Inspector, Penn. Lines, Ft. Wayne, Ind.....J. R. Conick
Wm. Langslands, R. H. F., C. & N. W. Ry., Chicago, Ill..........A. J. Filkins
W. A. Stockbridge, Penn. Ry. Co., Ft. Wayne, Ind...............J. R. Conick
A. W. Gillispie, Secy. Chicago Ry. & Mill Supply Co., Chicago, Ill., ...C. A. Nathan
L. P. Streeter, A. B. Engr. I. C. RR., 1371 E. 48th, Chicago, Ill...H. O. McClain
W. M. Baxter, G. M. Inspr. I. C. RR., Park Row Station, Chicago, Ill., ...H. O. McClain
M. J. Woodhull, Mgr. O. F. Jordan Co., Chicago, Ill.............S. T. Rowley
W. J. Devine, Gen'l Air Brake Insp., C. & N. W. Ry., Chicago, Ill., ...L. M. Carlton

MEMBERSHIP

Membership, November, 1911	1594
New members approved by Board of Directors	9
Total membership	1603

The list presented has been acted upon by the Board in the usual manner.

The proceedings of the last meeting have been printed, and I cannot say for sure whether distributed or not, but if there are no objections to them, they will be allowed to stand as printed and sent out.

I have here a letter that the Club has received, which I wish to read. It is from Mr. F. J. Angier, Secretary-Treasurer of the Wood Preservers' Association. Mr. Angier has been a member of the Western Railway Club since 1898, and accordingly the letter written by him is read for the benefit of any member who may wish to take advantage of his invitation.

Mr. J. W. Taylor, Treasurer-Secretary, Western Railway Club, 390 Old Colony Bldg., Chicago, Ill.

Dear Sir:—At your meeting to be held in Chicago, Illinois, on December 19th, will you kindly announce to the members that they are cordially invited to attend the 8th Annual Convention of the Wood Preservers' Association, to be held at the Hotel Sherman, Chicago, January 16th, 17th and 18th. A great amount of interest is being shown in this meeting, and we expect a large attendance. The following subjects will be presented and discussed at this meeting:

"The Scientific Management of Timber Preserving Plants"—D. Burkhalter.

"The Production of the Wooden Cross Tie"—A. R. Joyce.
"Preservation of Power Transmission Poles"—H. R. Wheaton.
"Inspectors and Inspection at Commercial Plants"—R. L. Allardyce.
"The Structure of Commercial Woods in Relation to their Injection with Preservatives"—Howard F. Weiss.
"The Effect of Fire on Creosoted Material"—R. J. Calder.
"Creosotes and Creosoting Oils"—David Allerton.
"Economic Materials for Boats and Barge Construction"—A. E. Hageboeck.
"Creosote Oil—Specifications and Analysis"—S. R. Church.
"Treating Seasoned vs. Unseasoned Ties"—F. J. Angier.
"Efficiency in Plant Operation"—E. A. Sterling.
"Preserving Treatment of Mine Timbers"—J. H. Nelson.
"Evaporation of Creosote and Crude Oils"—P. E. Fredondoll.
"Yard Arrangements and Piling Systems"—J. H. Waterman.
"Wood Block Pavement from a Construction Standpoint"—Day I. Okes.
"Cutting and Seasoning Timber"—A. Meyer.
"Creosote Specifications and Analysis"—Dr. H. von Schrenk.
"Creosoted Wood Paving Blocks"—A. E. Larkin.
"Expansive and Absorptive properties of Paving Blocks treated with Creosote Oil of a gravity 1.05 as compared with same properties of Blocks treated with oil of a gravity 1.12"—H. M. Rollins.

Thanking you in advance, I am,

Yours truly,

F. J. Angier.

The Chairman: This will bring us up to the paper of the evening by Mr. F. B. Farmer, representative of the Westinghouse Air Brake Company. Before Mr. Farmer reads his paper I would ask that any one speaking, if they will kindly give their names it will be appreciated, as it may be possible that I am not acquainted with them all, and we want to have their names to be included in the minutes of the meeting.

I take pleasure in introducing Mr. Farmer, and would ask that he kindly come forward and read his paper.

TERMINAL BRAKE TESTING

By Mr. F. B. Farmer, Representative, Westinghouse Air Brake Co.

In shooting at a target even a poor marksman needs a bulls-eye to make the best showing that he can. Though he may never hit the bulls-eye, yet his average will be higher if he strives to instead of aiming broadly at the target only. So, in each detail of railway work, we must have ideals to strive for, even though unattainable.

if we are to make definite and systematic progress. On the other hand, if in seeking these ideals we fail to observe or, seeing, ignore the limitations imposed by the times and circumstances beyond our control, we not only fail, but also hurt the cause we seek to forward.

Therefore, while having in mind the ideal of 100 per cent of brake efficiency at all times, I recognize that we can never attain it, but also that the average is far less, that the percentage varies greatly between various railways and that we can now consistently ask for a general improvement, especially that the roads with the lower efficiency come nearer to those with the higher.

Our major and controlling limitation is the dollar. Railways are built and run for profit and the measure of gain attained is mainly dependent on the *safe, expeditious* and *economical* transportation of freight and passengers. Without safety, wrecks, loss of life and minor damages increase; without expedition, a relative term, the business goes to other roads, for ''Time Is Money''; and without safety and comparative expedition there cannot be economical transportation. All else being the same, the relative degree of safety is, manifestly, measured by the comparative efficiency of the brakes. Expedition cannot mean higher speeds as that implies less safety and higher cost per ton and per passenger mile: Hence, it is obviously dependent, in the practical sense, on avoidance of unnecessary delays. True economy, then, is in spending no more in either dollars or time than necessary to obtain a relatively high, safe and expeditious movement of traffic, *but to spend that much.* The problem is to determine what these expenditures of time and money should be and how to make every dollar spent, and each hour consumed, go as far as possible. It is the writer's desire to contribute a little toward this end. Freight brakes only will be considered.

As faults cannot be remedied until located, the first requisite towards repairs is to locate the defective brakes. The next is to so mark the cars as to insure the earliest practicable repairs. While the use of the air brake defect card by train-men can help much, yet experience shows that we must depend mainly on the car men, including those in car shops and on repair tracks as well as yard inspectors.

As we seek efficient train brakes and as the standard set by law is based on the train, it is obvious that terminal brake tests of trains must be made. Stated differently, the requirements could not be met by confining inspecting, testing and repairing to shops and repair tracks.

Consideration of overtime and the sixteen-hour law, as well as expeditious train movement, demands the minimum lapse of time between that for which the crew is called and that when the train departs. Hence, a train prepared for departure should require no more brake work after the engine is coupled than, at the most, stopping a few leaks in hose couplings and making the formal test. But

often today there are greater delays due to making other repairs, or the train proceeds with less efficient brakes than it should have.

To avoid this, the repairs required must be determined with arriving trains. The incoming engineer should add to the reduction required for stopping enough to fully apply the brakes, and the brakeman should await his advice that this has been done before cutting off the engine. Car inspectors should be present to make an immediate examination and to bad order all defective brakes. Such repairs as ordinary brake pipe leaks, defective hose and wrong piston travel, those requiring little time, should next be made, but cars requiring heavy brake repairs should be marked for the repair tracks.

Here is where judgment must be exercised, as perishable or other very important loads as well as empties needed at once for such lading, must not be delayed. Neither should other less important cars be held in numbers far greater than the local force can repair in a day if such force is as great as the regular amount of work, including such repairs, would keep busy. The Car Foreman and the Yard Master should consult to adjust the foregoing, but when the former removes bad order marks without repairs having been made, he should fill out and apply an air brake defect card to better insure prompt repairs at the earliest practicable date.

However, it does not follow that the repairing of defective brakes cannot be done without delay to cars which should go forward promptly. The Soo Line Ry. has largely solved this problem at an important terminal yard by assigning a short track in the yard for air brake repairs to such cars. With a few men and needed repair materials, such cars received in transfers are often ready for the first train out, are never actually delayed, and few of such are allowed to go forward without repairs. This is but one detail of a very comprehensive scheme of improvement in freight brake maintenance effected by this road, and it is hoped that their Mr. C. P. McGinnis, General Air Brake Inspector, will contribute the valuable information which he can regarding this and other details coming under the subject of this paper.

As one repair point on a large system cannot maintain all freight car brakes, it is obvious that each terminal, with needed facilities, should do its share, but this does not mean that other than the outgoing test should be made on through trains at the points with small facilities. A brake well repaired will go for a long period without becoming defective, but the too common failure to do so, is due to inadequate repairs. To reduce the cost of brake cleaning by leaving cylinders and auxiliary reservoirs loose on the car is to insure leaky pipes. The same result follows if the brake pipe and retaining valve pipe are not well secured. That most serious fault, brake cylinder leakage, will develop sooner than it should, sometimes immediately after the cleaning, unless a suitable lubricant is employed

and packing leathers are replaced when a good inspection and a careful test would show that they should be. The practice often followed of cleaning and testing triple valves on the cars cannot insure good work. Neither is it common practice to test hose with soap suds while under maximum pressure and remove those found porous, or to examine the retaining valve weight and clean the case and small vent port. Until these and other details are given better attention in shops and on repair tracks, it will not be possible to effect the economy in time and money in terminal brake testing and the consequent repairs that will otherwise follow.

The M. C. B. requirement that cars in interchange must have retaining valves should imply the maintenance of this part and its pipe by the owning road. It is not sufficient to say that the mountain road may make needed repairs at the owners expense as this means undue delay to traffic. However, inspections show that the average efficiency of brakes is otherwise much lower on the cars of level grade roads, a condition for which there is no warrant as that for the average mountain grade road is enough below 100 per cent efficiency to justify making it the minimum.

That the regular terminal test of freight train brakes misses many of the defects which nullify the object sought in attaching air brakes, is conclusively demonstrated by the following: Within a few months competent parties made this test on several freight trains at the summit of a mountain grade, following a similar test by regular inspectors at the preceding division terminal, and out of which trains bound down this grade were supposed to leave with 100 per cent efficient brakes, based on such test. The test consisted of charging to 70 lbs., making a service reduction of 20 lbs. and rapidly examining for any brakes failing to apply or leaking off and incorrect piston travel. To show conclusively the oversights of the ordinary terminal brake test the infallible thermal brake test was made on each train at the foot of the grade. The customary plan was there followed of considering three cars with "warm" wheels equal to one with "normal" wheels; that is with a good brake. In addition to showing the results in percentage, they are given in "Tons per Good Brake," derived by dividing the train tonnage by the number of good brakes.

The first train given was a test train and had 2,501 tons. The other six were regular trains and ran from 2,252 to 2,367 tons, averaging 2,286 tons. Each train had a considerable percentage of foreign cars. No tests of or repairs to retaining valves were made:

Per Cent Good Brakes by Test Standing	Per Cent Good Brakes by Test Thermal	Tons per Good Brake by Test Standing	Tons per Good Brake by Test Thermal	Cars per Train
97.7	68.8	42.6	59.5	61
91.0	75.0	45.0	54.6	56
100.0	60.0	40.7	67.6	58
98.1	53.7	42.5	77.6	54
98.1	52.8	43.8	81.5	53
96.4	53.5	41.7	75.0	56
88.9	67.2	46.2	61.2	55

The big returns from good brakes are mainly concealed, consisting of the more expeditious train movement they make possible and the avoidance of accidents, neither of which can ordinarily be shown in dollars and cents. Their observable expenses, consisting of initial cost, maintenance, flat and cracked wheels and delays to cars and trains for brake testing and repairs, are so readily seen and tabulated as to generally render even more obscure their great but intangible credit account. The pressing need is for a more accurate and practical appreciation of the facts, that good brake maintenance is economy and for better directed efforts toward improved brake maintenance with a minimum increase in time and money spent. In this the active cooperation of the Yard Master and the Superintendent will aid greatly. Too often their efforts are directed toward showing why trains cannot be held or switching done for brake work, rather than how to accomplish the desired results with the least delay or additional switching.

AIR BRAKE TEST PLANTS:

While there is no question concerning the imperative need of available air pressure in car shops and on repair tracks, it is debatable as to whether it pays to pipe yards. I believe that usually it does not. If locomotives have insufficient air compressor capacity to charge their trains without material delay, they are not prepared to handle the trains safely, economically and expeditiously between terminals. Following the plan described of the brake test on incoming trains, and subsequent disposition of cars with defective brakes, will leave little need for a yard air test plant. The only safe or available time for inspectors to work on cars in yards is for a limited period after the arrival of trains and again following attachment of the outgoing locomotive. My observations show few exceptions to the foregoing.

A grave evil with many air brake test plants is the excessive amount of moisture. The ground cocks in their piping are commonly referred to as "hydrants." This should be a misnomer as it means a cock for controlling the flow of water, but it is too often quite applicable. As a brake pipe obstructed by ice is even more dan-

gerous than an accidentally or maliciously closed angle cock (the former cannot be seen), it is enough to say that water in test plant pipes may bring about frozen brake pipes. Triple valve and brake cylinder leakage from ice are other evils which follow. Also moisture causes corrosion of brake pipes and the rust clogs strainers and feed grooves and drys up the lubrication in triple valves and brake cylinders.

The cause of water in air testing piping is the result of insufficient cooling of the air between the compressor and the storage reservoirs, often magnified by inadequate number and location of such reservoirs. It is many years since the Air Brake Association investigated the same fault with locomotives and though the difficulties in the way of obtaining dry air for the brakes is there incomparably greater, solved it satisfactorily. However, it should be said in passing that many locomotives, even new ones, are not properly equipped and are a source of similar damage and danger. Inquiry of men using air test plants will soon disclose whether such furnish dry air, whether opening a cock will show visible moisture or moisten a surface against which the air is directed. If so, it is obvious that the remedy should be applied promptly. I venture the assertion that in comparatively few cases dry air, that free from visible moisture, is available.

In seeking means for testing and repairing air brakes without loss of time in transit, extra switching or danger to workmen the possibilities of the freight house tracks should always be investigated. Where the number of cars per day is considerable there is no doubt that the tracks should be supplied with compressed air and full advantage taken of this excellent opportunity for locating and remedying air brake defects.

In line with this idea of conserving time and switching, it is recommended that all cars in shops or on repair tracks, and having cleaning dates over nine months old, should have their brakes cleaned and lubricated. Not only will the condition of the triple valves and brake cylinders fully warrant doing this work then, but it is improbable that such cars will again be so favorably located for many months, without causing delay and switching.

This paper does not pretend to cover the subject exhaustively, but merely to point out broadly that brake maintenance is much less efficient than it should and can be, the important bearing that terminal brake testing has on it, and some of the practical ways in which a very considerable improvement can be effected and generally with the expenditure of less money and time than now often follows as the result of inadequate installation of and superficial repairs to air brake apparatus and as well, misdirected and conflicting efforts in its maintenance and traffic movement.

The Chairman: Gentlemen, Mr. Farmer's paper is before the Club for discussion, and I hope the members will feel free to

talk without waiting to be called upon. I understand that there is quite a number of the members of the Central Airbrake Club here this evening, and we certainly extend to them an invitation to get up and talk as well, and hope that they will. I would ask Mr. McGinnis, General Airbrake Inspector of the Soo Line, if he will not open the discussion of this paper.

Mr. Crawford P. McGinnis (Soo Line): Mr. President: In his paper Mr. Farmer has so completely covered his subject that the only points of interest which I might be able to bring out are those pertaining to the detail of the incoming and outbound checking tests as used on the railway I represent.

Fundamentally, each separate yard is depended upon to do its share toward maintaining the freight equipment brakes in the best condition possible. This is made possible by (1) a close inspection of the brakes on each arriving freight train; (2) caring for the brakes thus found to be defective, and (3) ascertaining the percentage of effective brakes in each outgoing train. Locally, the system is known as the In and Outbound Checking Tests.

It should be obvious to practical railroadmen, however, that varying conditions between terminal yards require a variance in administration of detail and it is here that the air brake inspector in charge of this branch of the work will be occupied in making the details conform to the natural conditions (though in some cases conditions have been changed thus effecting a betterment in each direction).

In a few words I may be able to make clear the plan of work required to protect the average division terminal.

The engineer is under instructions, issued in standard form, that before cutting off from his train on arriving at a terminal, a brake pipe reduction totaling 25 lbs. must have been made. He soon learns to follow up the reduction with which he brought the train to a stop, with such additional reductions as serve the dual purpose of preventing undue train stretching and obtaining the required total reduction. The trainmen, too, are under properly issued instructions not to close an angle cock in the train until the engineer's signal to the effect that the reduction is complete, is had.

The reduction having been made, the engine cut off and complete personal protection signals applied the air inspectors proceed with their work. If one man only is available for this work he begins, preferably, at the head end to make a hurried car-to-car inspection, stopping only long enough at each car to mark the defect, no attempt being then made to remedy the same. If two inspectors work the train they start from opposite ends, each covering the whole train.

The defects especially sought by the inspector are brakes which do not apply or which have leaked off before being noted by the inspector, cut out brakes, long-piston travel and air leaks of all

kinds. Each defect has its special mark, the system or marking being standard for the system.

After checking up the train they immediately take up the work of making such repairs as possible while train is yet under protection of signals. [The penalty defect inspection generally governs the length of time that protection signals are allowed to remain on trains]. Cars marked for long piston travel, 9 inches or over for incoming test, are generally all cared for before any switching is done, only a little time being required to take up piston travel, cut out brakes may be cut in and defective hose, marked while the train was yet under pressure, removed and replaced. Unless some exceptional note is required no car record of any kind is made during the incoming test. Cars bearing the air inspector's mark indicating that brake does not apply (or leaks off) are carded with B. O. AIR card which indicates that they are to be set to repair tracks, more time being required to put them in good order than can be given them on the yard tracks. At two of the larger division points short tracks have been given to such care and upon which tracks they receive prompt attention in order to avoid delay to certain classes of traffic.

So far, we have covered the general details required to carry out portions "a" and "b" of the fundamental plan. Portion "c" consists of the test for the effectiveness of brakes on the out bound train.

When the train is together and the hose coupled up the engine which is to handle the train is usually waiting to couple on.

If the engineer is following his instructions he will have obtained the maximum main reservoir pressure before coupling into the train and will afterward proceed to charge the train through the maximum or release opening of the brake valve. The air inspectors are caring for leaks while the train is being charged.

The brakes in the train are not considered charged and ready for test until *three minutes* after the feed valve, on the locomotive, will maintain at least 65 lbs. brake pipe pressure. This condition is indicated by moving the engineer's brake valve handle from release to running position in which latter position the black or brake pipe hand of the air gauge will remain at 65 lbs. or above if the brakes are approaching the charged condition. It must be born in mind, however, that a fair test for effectiveness *cannot* be made until at least *three minutes* are given the more sluggish triple valves to get their auxiliary reservoirs charged. the three minutes to begin when the feed valve is first able to support 65 lbs.

Before applying the brake with a 20 lb. reduction a short, warning blast of the whistle is given by the engineer. When the brakes have been applied the inspector begins a car-to-car brake inspection beginning with the engine, which is invariably checked as in good condition. The tender, however, is given the same considera-

tion as a car and the second line on the inspection book page bears the tender number with the sign which indicates the defect in the event of a disordered brake on the tender. This plan of checking is followed throughout the train. A standard book of 30 lines makes it easy to determine, quickly, the total number of cars in the train upon which is based the 85% minimum of effective brakes. The following table, indicating the greatest number of ineffective brakes permissible in trains of different lengths, issued in blue-print form and of a size convenient for attaching in the front of the book.

M. St. P. & S. Ste. M. Ry.

NUMBER OF INEFFECTIVE BRAKES PERMISSIBLE IN TRAINS.

A train of less than 7 cars must have no ineffective brakes.
A 7 to 13 car train must have no more than 1 ineffective brake.
A 14 to 19 car train must have no more than 2 ineffective brakes.
A 20 to 26 car train must have no more than 3 ineffective brakes.
A 27 to 33 car train must have no more than 4 ineffective brakes.
A 34 to 39 car train must have no more than 5 ineffective brakes,
A 40 to 46 car train must have no more than 6 ineffective brakes.
A 47 to 53 car train must have no more than 7 ineffective brakes.
A 54 to 59 car train must have no more than 8 ineffective brakes.
A 60 to 66 car train must have no more than 9 ineffective brakes.
A 67 to 73 car train must have no more than 10 ineffective brakes.
A 74 to 79 car train must have no more than 11 ineffective brakes.
A 80 to 86 car train must have no more than 12 ineffective brakes.
A 87 to 93 car train must have no more than 13 ineffective brakes.
A 94 to 100 car train must have no more than 14 ineffective brakes.

After some experience the men soon fall into their own methods of calculating the permissible number of defective brakes. If the train, on completing the inspection, is found to contain less than 85% effective brakes the long piston travel brakes are most easily made effective, a travel of less than 10 inches is required to make the brake effective. It goes without saying that all brakes must be cut in unless the car is "rush" and repairs cannot be made under which circumstances a defect tag, indicating the conditions, must be attached so that the car may be repaired at the first opportunity.

If "setting out" of defective brake cars must be resorted to the positions of such cars in the train are easily found by their numbers and positions on the inspection book pages and delay in switching reduced as much as possible.

When the train is ready to proceed a release brake signal is given which the engineer answers with a long and short blast of the whistle: To the conductor, wherever he may be, such a whistle signal indicates that the train is awaiting his signal to proceed.

The principle data of the inspector's book is transferred to an inspection record in the car foreman's office and used for reference.

In the outlying yards of the larger cities the incoming test is made on each merchandise transfer arriving from the loading platforms. It is very desirable that no delay in the movement of this class of freight be incurred and to prevent any possible delay a track, easily accessible to the switching yards, is provided and a crew for cleaning and repairing brakes maintained. The equipment for handling the brakes placed on this track contains every facility for shortening the work. Brakes marked out of the merchandise transfers are placed on this track in preference to other switching so that, by the time a train is made up these cars are ready to go and no delay is experienced. Seriously defective brakes are held over for the rip-track.

Home route foreign cars, arriving at connecting point terminals are delivered home regardless of their brake condition.

When first putting into practice this system of checking train brakes a great many details had to be worked out which have since been dropped because of the fewer number of cars with defective brakes. Insufficient track room for defective brakes was one of the early troubles.

The system was inaugurated in warm weather and we found much trouble in getting 75% effective brakes. At present the average is slightly above 92%.

In view of the foreign cars in the trains of each road it is now a question of how much effort each individual road is willing to spend toward increasing the efficiency of its freight brakes.

The Chairman: Has any one else anything to say? Mr. Cota, may we hear from you?

Mr. A. J. Cota (C., B. & Q. R. R.): I want to make some remarks on the very valuable paper presented by Mr. Farmer. The statement made that the first requisite of brake repairs is to locate the defective brake is true. We certainly must find where defects exist before we can make repairs. The next question that comes up is the proper place for making inspection to determine the condition of the brakes. The point is brought up in Mr. Farmer's paper that the brakes should be tested when the train is delivered to the yard. This refers to, I presume, regular freight train movements and transfer trains, and the question comes up are all yards so arranged that inspection can be made at the time of delivery. Mr. McGinnis has stated that in a certain yard with which he is familiar, it can be done. There are, however, some yards where deliveries are made at either end of the yard

and where a large number of transfer trains are delivered, it appears to me, it will require a force of men to inspect each train that may be delivered at each end of the yard. If the work could be done as outlined, it would be, in my opinion, ideal, as it would save a large amount of switching which naturally results in making up trains without knowing if the cars have defective brakes. However, I have always been in favor of a testing plant in make-up yards to thoroughly test the brakes on all out going trains before the engine is connected to the train. Mr. Farmer in his paper shows that a testing plant of this kind is not necessary where an inspection can be made as soon as the cars are delivered and if defects are found, the cars may be switched out and repairs made before the train is made up. It remains to be seen whether the transportation department would agree to the time being taken for that work. I suppose this phase of the subject will be discussed very thoroughly by others here.

The Chairman: Gentlemen, there is probably no more live subject than this. I am thoroughly convinced there are men here tonight who have questions they want to ask Mr. Farmer, or points they can give us, and I wish they would get up voluntarily and keep the discussion going. You were all here, probably, more or less last year and heard Mr. DeVoy threaten from the chair that he was going to name certain people to get up and speak, and now he is sitting still tonight and saying nothing. I am going to get back at him and ask that we hear from him.

Mr. J. F. DeVoy (C., M. & St. P. Ry.): I did not have an opportunity to read over the paper presented this evening and have only heard the latter part of the speaker's remarks, and will say that I do not exactly know why Mr. Farmer has taken the position that an air brake testing plant is not a necessity and that it is debatable as to whether it pays to pipe yards where the air brakes on trains are to be tested.

Although there may be some disadvantages of piping a large yard, such as moisture in the pipes, etc., still, there is this advantage to be gained by its use, that is, that the work of testing and examining the brakes on a train can be carried on, without depending upon the air from the locomotive, as there are often times cases, when the entire train could be gone over while awaiting the arrival of the locomotive, which may have been delayed due to a failure, shortage of power, or other numerous causes, and by the time the locomotive is coupled to the train the inspectors can have all the defective air brake cars carded, so that with the least possible delay the defective cars can be set out, and the light repairs such as brake pipe leaks, piston travel and defective hose, have been taken care of before the locomotive reaches the train. if the delay to engine has been of any length.

In case the incoming crew was approaching close to the 16

hour limit, and they were depended upon to make the test of train, when the hour limit was reached, even in the midst of the test they would have to stop work, but if yard was piped, as soon as train arrived the engine could be cut-off by engine crew and moved to round house or siding for engine handler, so it would sooner reach the house to have the necessary attention given it, and therefore, would be sooner available for service.

As soon as the engine was removed from train the air from the yard pipes could be cut into train and the work of inspecting and testing the brakes could go on with no further delay.

It may be all right to lay down certain rules to go by, and to follow a certain system, but, when a pipe or a nipple breaks on a locomotive hauling one of your principal trains, you will have to break away from the rule book or system, and do whatever you can to get that pipe or nipple in condition again so it will do the business with the least possible delay.

I have advocated two air pumps on a locomotive so as to protect against failure, but the economical side must be taken into consideration. It costs money to do this sort of thing, and it hardly appears that the Railroads are earning money enough to go into this luxury.

I made a statement a couple of years ago that I did not know whether all of the recommendations made by the air brake people were exactly what they ought to be. We have gone a long way in air brakes; so far that the brake shoes will slide the wheel on account of the high braking power, which I am told is not 80 per cent of the light weight. But I will say one thing, that if you will follow the rule that you want in applying brake pressure to wheels, you will have to get busy and make a wheel that will stand the pressure that you have created.

Some of you gentlemen must read the 7:00 A. M. delay reports, and although we follow all the instructions as laid down in regards to brakes, still they continue to be troublesome, but what I would like, is to have somebody tell me how we could reduce these failures.

It is always instructive to have a man of Mr. Farmer's calibre talk on the subject he is following, and it is also to me, and I believe to the rest, to hear a man talk as has the representative of the Soo Line, but, Mr. Chairman, I still adhere to the idea that some of the gentlemen here know more about this subject in a minute than I do in a day.

You have disposed in a summary manner of my Czar Reed rules that I had in force during my incumbency in the Chair, still I think I have never found the time when I thought they were wrong, and I think you had better get after some of those fellows, and have them tell us what they know, and do not let them sidestep either.

The Chairman: I have all their names, and I am going to call them pretty soon, if they do not get up.

Mr. DeVoy: I would.

The Chairman: Cannot we have some one else talk voluntarily on this subject? I believe Mr. Riley of the Michigan Central is here, or Mr. White, if I have the name right. If he is in the room, we would like to hear from him.

Mr. W. W. White (Michigan Central R. R.): I am not prepared to make any extended remarks on the paper; I did not read it before it was read at the meeting. I agree somewhat with Mr. Cota; I think, however, that the local conditions surrounding the handling of trains on each railroad will govern largely the method employed in testing out the air brake. If the conditions will permit of making the test and switching out cars for repairs as outlined in the paper and as has been spoken of by Mr. McGinnis, it is a very satisfactory and rational system of doing the work, but I think the air brake men at least will agree that it is not altogether satisfactory to obtain the efficiency required and I believe that some sort of testing must be supplemented to some extent by yard testing plants. The question of yard testing plants has been so much discussed that it is not necessary to go into the details now, but it appears to me that one way of handling the terminal testing of air brakes is to extend the repair track piping across the tracks in yards where it can be done so as to reach the incoming or outgoing trains. That will not entail a great deal of extra expense and does not necessitate the installation of an expensive plant, especially for testing trains that are made up in the yard, as it is merely supplementary to the repair track plant, and where the conditions will permit utilizing such a plant, I think it will be found very useful. However, if the work can be done without any piping in the yard, it is, of course, cheaper to do so. The question of economy set forth in Mr. Farmer's paper is one of the principal things that has held us back with air brake testing for some time and it does now, for many roads hesitate to install air brake testing plants for the reason that their conditions require a separate plant being installed for the purpose of testing the trains in the yard. Therefore I think if it can be done with the road engine and possibly with only the car inspectors who must be employed in the yards anyway, that is, to avoid special air brake men for the testing, it is an economical method of obtaining a partial improvement in the condition of the air brake equipment.

The Chairman: Mr. Miller, may we hear a talk from you on this?

Mr. E. A. Miller (N. Y. C. & St. L. Ry.): Mr. President, I supposed that I was stranger enough here not to be called on, and I hardly think it is fair to call on me when I was just enjoying the pleasure of my first attendance at the Club. I was just thinking that my attention was first called to the air brake about forty-five years ago, when as a boy I heard the unusual exhaust from the

air brake which I had not before noticed on any engines. That was, at least, among the first engines equipped. Later when I went into the Pennsylvania Railroad shops as an apprentice, after a few months, I supposed I knew all about the air brake and all about the locomotive. At the end of my apprenticeship I found out there were still some few things that I could learn, and today, after about forty-five years, I find that there is still a great deal that I have to learn, if I keep up with the evolution of the air brake. I have been interested in all that has been said this evening; I do not think we can have too much information on the question of best methods in handling the air testing at terminals. I am like my friend, Mr. DeVoy; what I am especially interested in at the present time is how we can most quickly test the air and keep the trains moving. We must have quick movement, and, as has been said, what we want is the help of the air brake men to show us how to so equip our trains, our cars and engines, that the defects will be eliminated, and the trouble from broken pipes, broken connections, bursted hose, rough gaskets and all the other little mishaps that come up, can be avoided and trains kept moving from one end of the line to the other. I say, this is a live question, and I think we all appreciate very much the paper and what has been said, but after all, the essential of the whole thing is, how we may most speedily take care of the traffic that must be kept going.

The Chairman: I see you are going to compel me to keep referring to this list. Is Mr. Devine, of the Northwestern, here?

W. J. Devine (C. & N. W. Ry.): From what I have heard this evening one thought has entered my mind and that is this: Is there the proper cooperation between all other departments and the air brake department? This is necessary else much time will be lost and good results are not gotten. To explain: I remember once of talking with a division official on the question of air brakes and brought up the necessity of tests. He said, "Now look here, you are looking at that from an air brake standpoint and I am looking at it from an operating standpoint." Now we know and admit that the operating standpoint is necessarily large, but if he did not have the air brakes behind him to broaden the point, I am certain it would be very small.

If you have a good air brake you have something to stop with, and you can only run your trains so fast and that depends on the distance in which you can stop it. In order to do this you must have a foundation and that is the brake test. Whether it will pay to make this first or last remains to be figured out for each individual road.

Just compare what time is lost by allowing a defective car to be placed in a train and then have to set it out again is shown by the following. It was at a terminal recently where a 45 or 50 car train was being tested. About the sixth car from the way car

there was a broken cross-over pipe so the car could not be cut out. This car had to be removed from the train before we could proceed, and the time lost in doing so, was, I believe, more than it would have taken to have made the tests as the train came in. We must not forget also that some defects occur even after the car has entered the yard due to rough handling in switching, and we all have it to contend with.

I did not have a chance to read this paper only as I went through it as Mr. Farmer read it, but I believe this question can be worked out and get better results than we are now getting.

The Chairman: Mr. Bailey have you anything to say? Mr. Streeter, of the Illinois Central.

Mr. L. P. Streeter (I. C. R. R.): I did not expect to be called upon this evening for my views on what is certainly a live topic of interest to all air brake men and, in fact, all railway men in general. The gentleman from the Chicago & Northwestern has, in my opinion, gone to the heart of the matter, namely the cooperation between operating and mechanical departments, necessary to realize and meet those conditions of maintenance brought about by long and heavy tonnage trains with the minimum delay at terminals.

Up to October 1st of this year I was connected with the Southern Pacific Company (Pacific System), where the air brake is given the attention commensurate with its importance, and I might add that some of the best support accorded me by an operating official came from a former C. & N. W. man—Mr. W. H. Whalen, now superintendent of the Los Angeles Division,—who realized the advantage of maintaining the brakes at their highest efficiency, and extended the necessary authority to hold trains at terminals until such condition was assured, and I do not know of a single instance where such action did not work to the advantage of all concerned.

As to the time required to put all the brakes on a freight train in operative condition, adjust piston travel, etc., opinions differ. However, I have in mind an instance where one of our important manifest freights was held at a division terminal for about five hours, to put the brakes in first class shape. This equipment was received from the Eastern lines via El Paso, and while the delay appeared at the time somewhat excessive, the example resulted in a marked improvement all along the line. This case is cited as it represents an extreme.

The question of yard air lines has been brought up by the author of this paper, and while I have cooperated with Mr. Farmer on many occasions over the California grades, and have a due appreciation of his ability, it appears to me that he has rather underestimated their value.

I believe properly constructed and maintained yard air lines are necessary to determine the exact brake conditions before the

outgoing engine is placed on train, thus eliminating possible terminal overtime. However, the value of such installation is largely dependent on arrangement of trackage, which should always be given due consideration.

As yet I have not had the opportunity to give you, from experience, the results of yard air line practice on the Illinois Central. However, we are continuing work along this line, where conditions seem favorable.

On the Southern Pacific yard air lines were installed at many of the important points, and resulted in a saving of time and corresponding increase in efficiency, and I believe from experience that their value has been proven beyond any doubt.

Mr. W. E. Symons (Consulting Engineer): Mr. President and Gentlemen: Not being an air brake specialist, I of course, fully expected to speak on this subject this evening, especially in view of the fact that there are a number of gentlemen here who are air brake specialists and are well equipped to thoroughly discuss the paper presented by Mr. Farmer and give as much additional information from the different angles of their view as the result of their experience warrants. In looking over the paper there is only one thing that I recall just at this moment in which I would differ from Mr. Farmer, and that is not a serious difference. This has been mentioned by one of the previous speakers, and is in respect to the piping of yards. I have no doubt, however, that Mr. Farmer spoke from the economical standpoint, and from that standpoint of course it is desirable to avoid as much expense as possible or as can conveniently be done, particularly in the way of duplication of air testing plants along the line of railway. As a general proposition, however, I am inclined to favor an air plant in yards, not because it gives an opportunity to spend money, but because it provides complete facilities for carrying to a successsful issue certain operations necessary in train movement. The testing of brakes by the engineer of the incoming train has no doubt been generally successful, as has been mentioned here this evening, yet if that practice should be extended and become what might be termed a fixed rule on roads, and there should be some delay in the performing of this operation, the probabilities are that the question would arise among engine men, as to what was required of them after they had delivered the train into the terminal. The enginemen are all working under contracts, and on most of the roads those contracts are very literally interpreted; they are also very zealous of their rights, and they might well be so, because if not, they might be required to do some considerable work in addition to hauling their trains. Then there is, I think, as a general proposition, an understanding among the men that when a train is delivered at the terminal yard, the engine cut off and goes to the roundhouse, that their connection with it ceases. It only takes a

few moments, of course, to test air and set the brake, but if the question should come up, say a man may have been dismissed, and the question of his reinstatement comes up, on the grounds that under the contract, no violation of discipline could be charged as the man had earned his compensation and was asked to do something in addition thereto. I think he would probably be excused on that ground. Therefore I think the yards should be provided with ample facilities for testing air brake regardless of whether the engine is coupled to the train, either incoming or outgoing. There are a number of gentlemen here tonight who have not yet spoken, and if you will pardon me for suggesting it, I think we should be glad to hear from them.

Mr. McGinnis: It perhaps is not properly understood that the reduction required to bring the train to a stop is made sufficient to meet the test requirements and no delay whatsoever is experienced. There is no additional application after the train comes to a stop.

The Chairman: If there is no one who has anything further to say, I will ask Mr. Farmer to close his paper, if he wishes to say anything in answer.

Mr. Farmer: I regret that those who have spoken had not the opportunity of carefully reading the paper, for the expression of almost all show a misapprehension regarding the fundamental features of the paper and which latter, when understood, would put us in entire harmony. These features are better brake maintenance with less delay to traffic than at present.

The first requisite for this is to make brake repairs when cars are empty and without delay to those wanted for loading or being loaded. No one will question the desirability of this, and any who will investigate the possibilities will be convinced that piping freight sheds and team tracks for brake cleaning and testing; cleaning brakes on all repair track cars with dates over nine months old, even though such brakes are apparently in good order; doing better work when installing or repairing brakes; using the "B. O. Empty" marks on loads arriving in the yards of terminals they are destined for; and sending to repair tracks at once empties with defective brakes when such cars are not then needed for loading will do much toward these desired ends.

The very annoyances implied by references to the "7:00 A. M." reports are due, so thus far as they pertain to air brakes, to not working on the lines just mentioned. We have approached the subject of brake maintenance the wrong way, either by requesting time for making repairs after the crews are called and all operating officials are wanting the train to proceed or by asking for an hour or more to make such repairs between the time the train is made up and that for which the crew is called. To assume that the latter is not a train delay is to beg the question. Overtime and the sixteen-hour law are not involved, but the train is being delayed

just as much as though the crew were there. All such delays reduced the earning on the car investment and in times of stress increase the car shortage.

These same conditions are also largely responsible for the apparent lack of sympathy of Yard Masters, Train Masters, Dispatchers and Superintendents with air brake repairs to freight cars, as the methods are directly in opposition to the results they are being pressed to obtain, viz., expeditious movement of traffic.

The incoming brake test is the next step in the desired direction. It involves the fewest and briefest delays to loads with defective brakes, but not to other loads. Without it, and assuming that the brakes on 5 per cent of the cars in each freight train are given heavy repairs or switched out after the trains are made up, you are delaying 95 per cent which otherwise would have gone forward promptly and, when the 5 per cent is switched out, increasing the labors of switching crews and delaying the making-up of other trains. If the 5 per cent estimate does not appeal to you for any reason, then change it either way and see whether the situation is improved, bearing in mind all of those involved features which other speakers have emphasized.

I am not against the yard testing plant where it is a success, but in other than exceptional cases have not found it so in the Northwest. This plant should not be confused with the repair track testing plant, as I fear Mr. De Voy has, as I have emphasized the imperative need of the latter. I would recommend a yard testing plant, even though it delayed trains, if organized and well directed efforts could not secure good brake maintenance otherwise, but not until then.

Please understand that these views are my own and that I am not authorized to speak for others; also, that the suggestions made are not theoretical, but cover practices which have passed beyond the experimental stage and which promise much for the future.

The Chairman: Gentlemen, if there is nothing further, this will close the evening's discussion. I think the Club owes to Mr. Farmer a vote of thanks for coming here and giving us the benefit of the paper, and also to the air brake men who have come up here and entered into the discussion. A motion to that effect will now be in order.

Mr. Symons: Mr. President, I move a vote of thanks to Mr. Farmer for his valuable paper before the Western Railway Club.

Motion was seconded and carried by a rising vote.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, January 16, 1912, President C. B. Young in the chair. The meeting was called to order at 8:30 p. m. Of those present the following registered:

Baker, R. M.	Hayward, O. C.	Pflager, C. H.
Burcham, J. H.	Hunter, P.	Prentiss, G. N.
Bryan, L. H.	Jansen, E. W.	Powell, C. R.
Casgrain, G. D.	Jennings, D. F.	Schlacks, W. J.
Covert, M. F.	Jones, L. E.	Scribner, J.
Crawford, J. G.	Kempf, G. P.	Seeley, J. S.
Dix, G. E.	Kinsman, C. C.	Seidel, G. W.
Doud, Wm.	Lorenz, J. W.	Sheafe, J. S.
Evans, W. H.	Lovell, C. P.	Sisson, V. E.
Fogg, J. W.	Lundehn, Otto	Streeter, L. P.
Friday, C. B.	McAlpine, A. R.	Struble, C. H.
Fugate, F. L.	Midgley, S. W.	Taylor, C. O.
Gardner, H. A.	Miller, C. E.	Taylor, J. W.
Gillespie, A. W.	Morrison, P. H.	Toohey, M.
Gilpin, G. G.	Motherwell, J. W.	Totten, A.
Goodnow, T. H.	Naylor, N. C.	Walsh, W. J.
Graber, G. A.	Neeley, E. J.	Wilcoxson, W. G.
Hall, N. B.	Olson, O M.	Woods, M. S.
Hall, W. B.	Ortman, I. M.	Wright, Wm.
		Young, C. B.

THE PRESIDENT: The first order of business is the approval of the minutes of the last meeting. These have been printed and are on the way to you now.

The next in order will be the report of the Secretary.

THE SECRETARY: Mr. President, I have the usual membership statement.

NEW MEMBERS

Name	Occupation	Address	Proposed by
C. C. Schumaker, Mgr. Carborundum Co., Chicago			J. W. Taylor
A. L. Rockwell, Chemist & Insp. Ill. Central R. R., Chicago			J. S. Sheafe
B. Pratt, New York Air Brake Co., Chicago			C. P. Lovell
C. W. Cross, Supt. Apprentices N. Y. Central Lines, Chicago			J. W. Taylor
W. F. Ebert, Crandall Packing Co., Chicago			J. W. Taylor
G. W. H. Thomas, Amer. Steel Foundries, Chicago			J. R. Stuart
P. C. Jacobs, H. W. Johns-Manville Co., Chicago			J. A. Meaden
O. M. Carry, S. A., Amer. Car & Fdy. Co. Chicago			Andrew Speirs
J. S. Miller, West'n Mgr. U. S. Metal & Mfg. Co., Chicago			Andrew Speirs
J. M. Lorenz, Central Electric Co., Chicago			J. W. Taylor
R. M. Baker, Central Electric Co., Chicago			J. W. Taylor
J. H. Nash, Shop Supt. I. C. R. R., Chicago			J. S. Sheafe
G. A. Graber, Kerite Insulated Wire & Cable Co., Chicago			B. L. Winchull, Jr.
R. M. Osterman, Locomotive Superheater Co., Chicago			G. L. Bourne

MEMBERSHIP

Membership, December, 1911	1,603
New members approved by the Board of Directors	14
	1,617

Those are all the statements I have, Mr. President.

THE PRESIDENT: It does not appear as though every one has a copy of the paper. Here are a number of them, and I will ask Mr. Hunter and Mr. Jones if they will not kindly distribute these to the members present.

The paper of the evening is entitled "Head End Electric Train Lighting," by Mr. C. R. Gilman, Chief Electrician of the Chicago, Milwaukee & St. Paul Railway. Mr. Gilman will now read the paper.

HEAD END ELECTRIC TRAIN LIGHTING.

By Mr. C. R. Gilman,

Chief Electrician C., M. & St. P. Ry.

Not since Mr. Ott gave us his valuable paper on this important subject in April, 1907, has there been much written or much discussion on head end train lighting before this Club.

The business has not stood still, however, but has steadily advanced, and while it is still an open question which system best meets railway conditions, head end lighting is taking a more important place today than it ever has before in the railway world, and I believe will continue to hold its place in electric lighting of cars for a long time to come.

The general system of head end train lighting is the same as used 15 years ago, there have been a number of improvements and changes made. These, with the adoption of the new types of

electric lamps, storage batteries, fixtures and reflector glass ware, makes this system very efficient and reliable, where first-class uniform lighting is required on a heavy train.

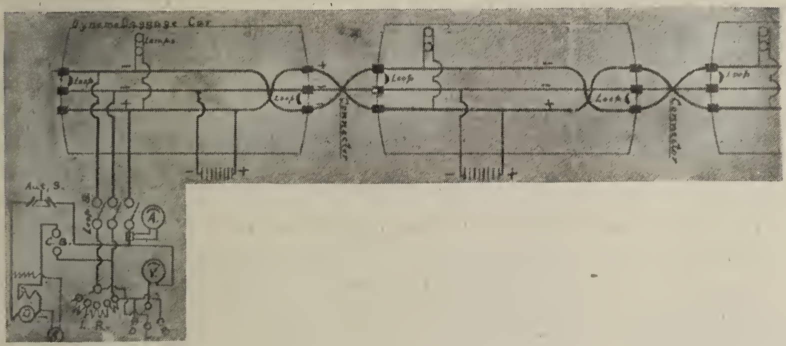


Fig. No. 1.

While some of you are acquainted with the method of operation of a head end lighted train, a short description is thought necessary to enable others to better follow the paper. A head end system is

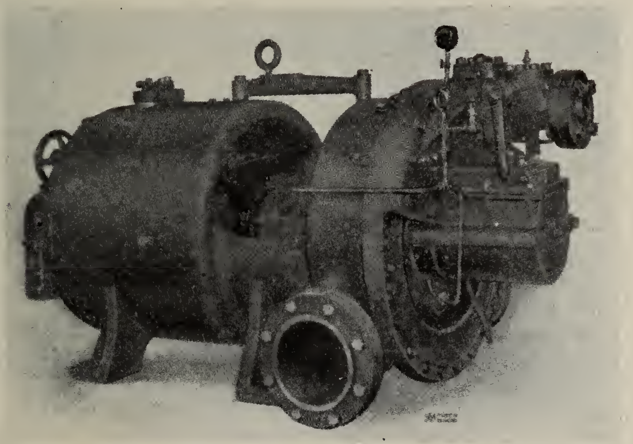


Fig. No. 2.—25 and 35 kw. Curtis Turbine

one where a steam turbine driven dynamo is placed either on the locomotive or in the baggage car, taking steam from the locomotive to operate it. Auxiliary lighting is maintained, when locomotives are changed or cars stand in terminals, by two, three or four storage batteries, depending on the number of cars in train. These batteries float on the main train wires in parallel with the dynamo, lighting

the lamps should any thing happen to dynamo, turbine, steam hose or train part and pull out a connector. Figure 1 shows general wiring diagram.

As all the cars on a train are expected to be lighted from the "Head End" unit and trains sometimes are made up of 18 cars, I am going to take a 17-car train as an example.

Equipment

Figure 2.—One 25 kw. Curtis tubo generator, 3600 R.P.M. 110-125 volts.

Figure 3.—Switch board and dynamo connection in baggage car.

Figure 4.—Automatic loop connectors.

Figure 5.—Standard 2-compartment tray of train lighting batteries.

The train is made up as follows:

1 dynamo baggage car	14 lamps
2 mail cars	66 lamps
1 mail tender	8 lamps
1 Comp. sleeper	60 lamps
1 12 section sleeper	80 lamps
1 buffet car	82 lamps
5 12 section sleepers	400 lamps
1 dining car	42 lamps
1 parlor car	42 lamps
3 coaches	78 lamps
17 cars	872 lamps

Eight hundred and seventy-two 104 volt 8 c.p. lamps are used and the total lamp load is 20,627 watts. The losses in machine and train lines is 22 per cent. so the load on dynamo is 25,219 watts, which is the full capacity of the machine.

In actual operation we seldom get continual steam pressure enough to operate this load, so allow the storage batteries to help out until the number of lights is reduced, as passengers retire for the night.

Our batteries are connected in parallel with the lamps on the two outside mains, and float on the lamp system. Later when the sleeper passengers have retired and the load largely reduced we raise the dynamo voltage to 118 or 120 and give the batteries what is known as a floating charge. One hundred and twenty (120) volts is not high enough to properly charge the batteries but was as high as we deemed advisable to run our lamps. We found, however, that the batteries took a fairly good charge and with an initial charge in the yard at full capacity twice a month they remained in good condition.

Early in 1910 I went seriously into the subject of charging batteries on the trains, as our charging plants are small and the number of batteries to charge continually on the increase. Charging batteries enroute require plenty of current, lamp regulation and means to determine the amount of charge and discharge the batteries are receiving.

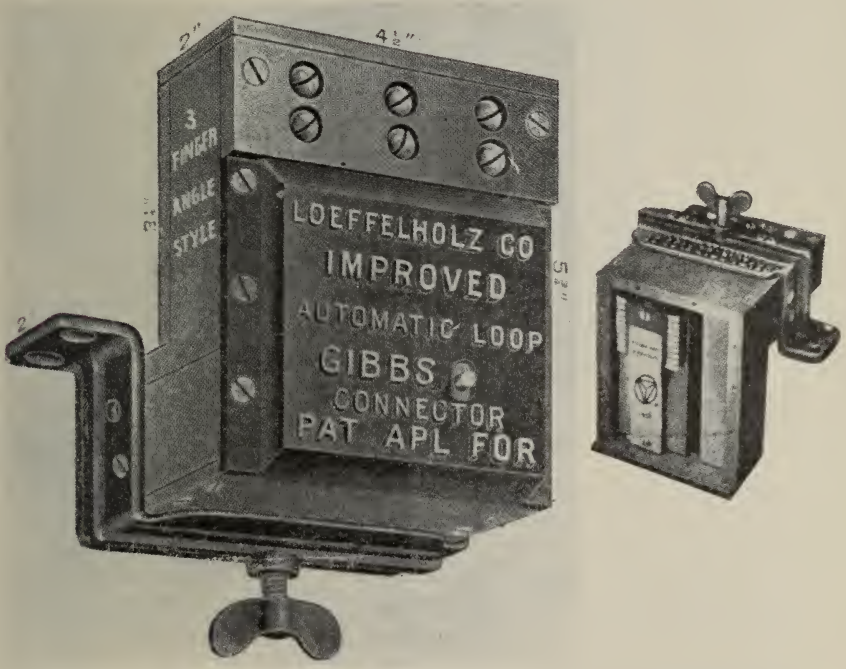


Fig. No. 4.—Main Connector with Automatic Loop Switch.—Cover removed

Fig. No. 4 —Electric Lighted Main Connector

While there are a number of very good automatic lamp regulators on the market, they are quite expensive and each car on the train has to have one. Owing to the large number of cars required to make up this train, the cost of automatic regulators would have been over $1700.00, and we cast about to see if we could not substitute some means to accomplish the desired results at less expense. Without altering or adding to the present three wire standard, this we have done by connecting the battery to the same main wires as the dynamo and placing a hand operated resistance in the main lamp return wire, in baggage car. This lamp resistance is brought into use by opening the connector loop in rear of train and closing it on switch in baggage car. Figures 1 and 3.

On account of the high steam pressure needed to operate the dynamo, the baggage car is run next to the locomotive. On this train there are three mail cars without end doors between it and the train. Our baggagemen therefore, cannot get into the train while it is in

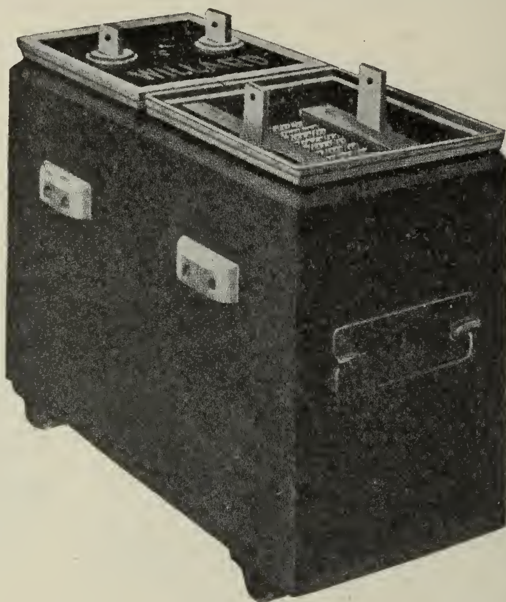


Fig. No. 5.—Standard 2-Compartment Train Lighting Battery

motion and as they operate the electric lighting, it is very necessary for them to have simple rules to run by. I will therefore quote our charging instructions as they fully explain the operation of charging the batteries.

Instructions to Dynamo-Baggagemen.

At about midnight or when lamp load has fallen to the minimum begin charging.

Arrange previously with rear-brakemen to open rear connector loops.

Better arrange to do this at some station. Just before arriving at this station throw in your front end loop, otherwise train will be in darkness as soon as rear loop is opened.

Now, with everything running as it should be, put volt meter switch on lamps, throw in first point of large lamp resistance. That will lower voltage, raise lamp voltage to 104. Now read dynamo voltage, if it stands at about 128 or 130 let it alone; if not, throw large resistance to No. 2 and again raise lamp voltage to 104. Con-

tinue this until you have about 104 volts on lamps and 128 to 130 volts on dynamo. Let it run now until ampere load has fallen to about 5 or 10 amperes for each battery back of your car in addition to the lamp load. Then shut down dynamo. Pay particular attention to the amount of steam necessary to operate the dynamo and call for as little as possible. This is very important. It saves coal, saves steam for the locomotive (where it is sometimes badly needed) and saves bursting steam hose, an expense to the company, delay to the train, and trouble to yourselves.

Figure 4 shows an automatic loop connector to open the loop, it is only necessary to insert the male connector. Therefore, if all connectors are in place there are no loops in the train except the one on rear of last car. Should train part from accident or is parted for switching, as soon as male connector is taken down the automatic loops immediately set, forming a circuit for the current, either from the dynamo in front, or battery on last part of train.

The total cost of equipping a train for this system is $67.50. This includes hand lamp resistance, automatic cut out in baggage car and extra main car feeders brought from roof main down to switch box and connections made in 4-battery cars.

The controlling of the charge is done by having ampere hour meters in circuit with each battery. These are read at terminals and baggage men advised to charge more or less as the conditions demand.

Lighting a 17-car train having over 800 lamps, and being about a quarter of a mile long is no mean undertaking, and on account of the heavy all night load (75) seventy-five amperes it was found hard to keep the batteries charged and give satisfactory illumination. I therefore suggested to our people that we reduce the load on this train by adopting 60 volts, and using tungsten and tantalum lamps.

Many of you are aware that for more than two years I have been a strong believer and an earnest worker in endeavoring to bring about a standard of 60 volts on all the head end lighted roads, and while most electrical men can see advantage in it, the mechanical people so far on some roads have not taken it very seriously. It gave me great satisfaction, therefore, that our people allowed me to try it out on the Pioneer Limited.

On November 10, 1910, this train arrived in the yard at 11:00 A. M., 110 volts, and when it left at 5:30 P. M. had been changed to 60 volts, lamped and tested. The operation that night was all that was expected and the lighting was beyond reproach.

To convert the 110 volt dynamo into a 60 volt machine, we placed an extra field rheostat in series with the old one and a shunt across the compound field terminals. I had previously tested out a number of these generators and knew just what to do with them. The cost of converting this machine from 110 to 60 volts is $7.50. This added to the $67.50 made a total expense per train of $75.00.

Figure 6 is a test sheet of this train at 64 volts.

You will note by comparing it with test No. 7 of 104 volt train that the amount of steam required to operate dynamo averaged about 18 pounds less. That the battery charging current available was 50 per cent. greater. The voltage was more uniform, 12 C.P. lamps were used instead of 8 C.P., increasing the light on train 60 per cent.

Now let us compare the operation costs of the two systems.

As there are six items that differ in each train operation, we will compare them only.

Consumption of steam.	Lamp renewals.
Weight hauled.	Yard labor.
Battery depreciation.	Total candle power.

110 Volt Train, See Sheet No. 7.

We find that on a 110 volt train the average load was 14.96 kw.

Taking tests made by Mr. Wray, Bulletin No. 268, University of Wisconsin, for the efficiency of the turbine, we find that at 15 kw. load 88 lbs. of steam was used per kw.h. 88x15 kw. equals 1320x19 hours per trip equals 25080 lbs. steam used. This divided by 5:5 lbs. water evaporated per lb. of coal equals 4560 lbs. as used per trip 182 trips per year equals 829920 lbs. coal divided by 2000 (lbs. per ton) equals 415 tons multiplied by $2.00 equals $830.00.

Cost of Hauling Batteries.

Four sets of 54 cells each, 216 cells at 173 lbs. each equals 37368 lbs. divided by 2000 (lbs. per ton) equals 18.68 tons, 820 miles per trip multiplied by 182 trips multiplied by 18.68 equals 2,787,803 ton miles multiplied by .0015 cents per ton mile equals $4,181.70.

Battery Depreciation.

Battery depreciation figured at 15 per cent	$679.40
Yard labor	554.80

Lamp Renewals.

Carbon lamps cost 20 cents each, 5232 lamps were used, which equals $1046.40.

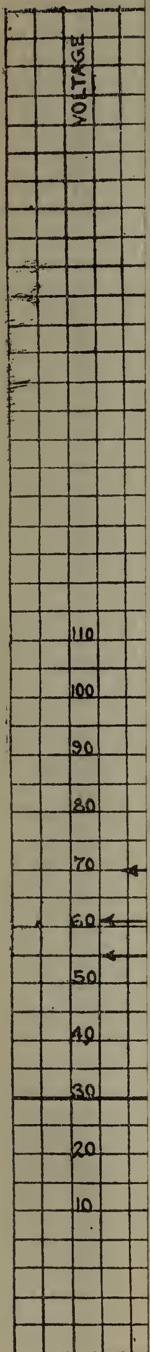
60 Volt Train, See Sheet No. 6.

The average load is 10 kw., the average steam used is 105 lbs. per kw.h.

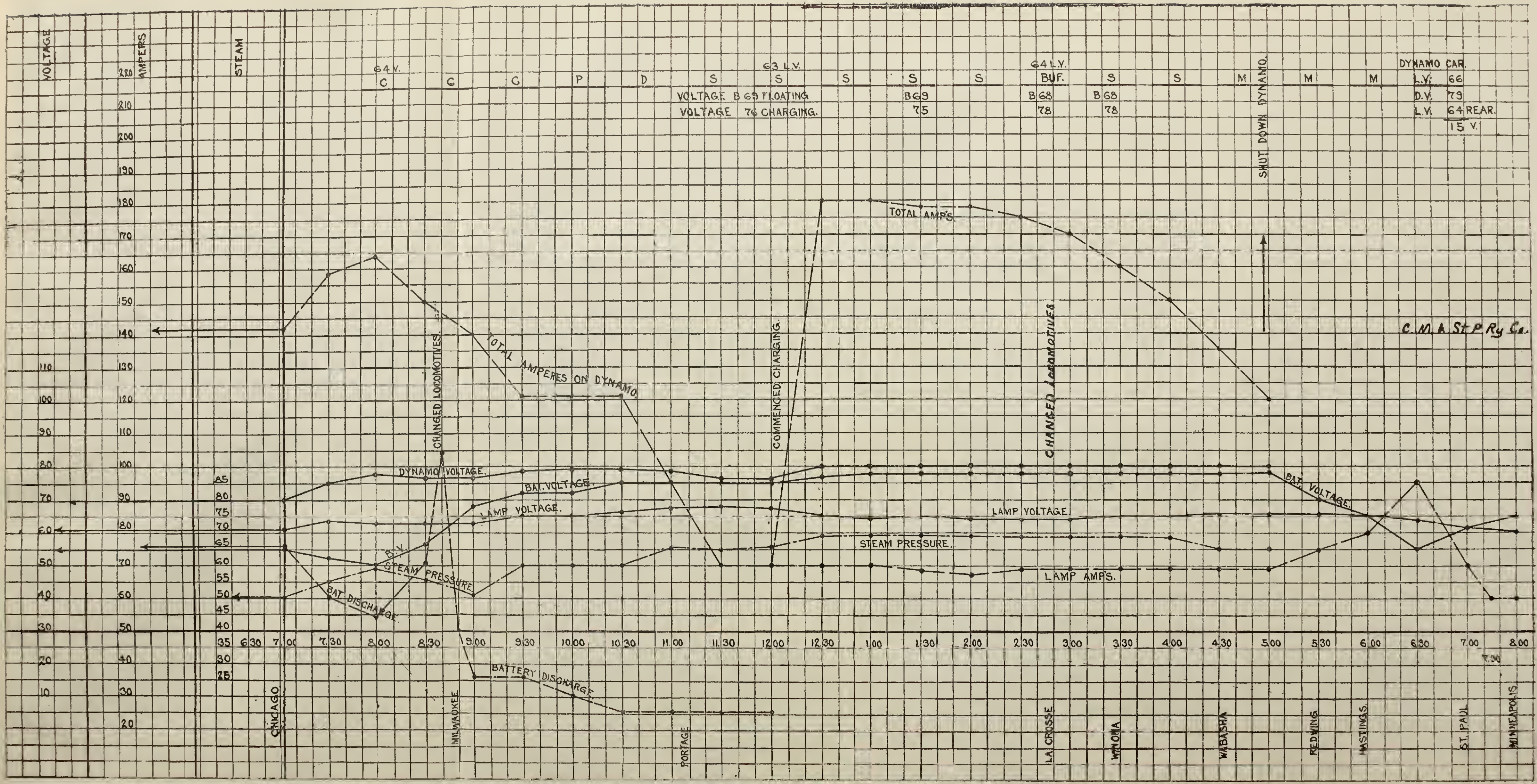
Figured in the same as for the 110 volt train the cost of coal for this train was $660.00.

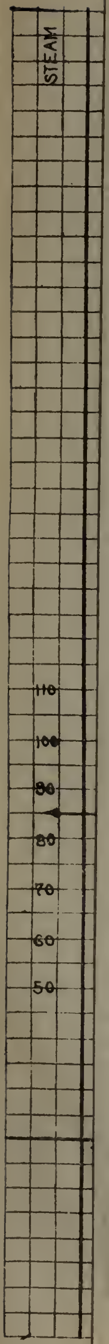
Cost of Hauling Batteries.

Four sets of 32 cells each 128 cells at 173 lbs. equals 22144 lbs. or 11 tons equals $2,503.80.

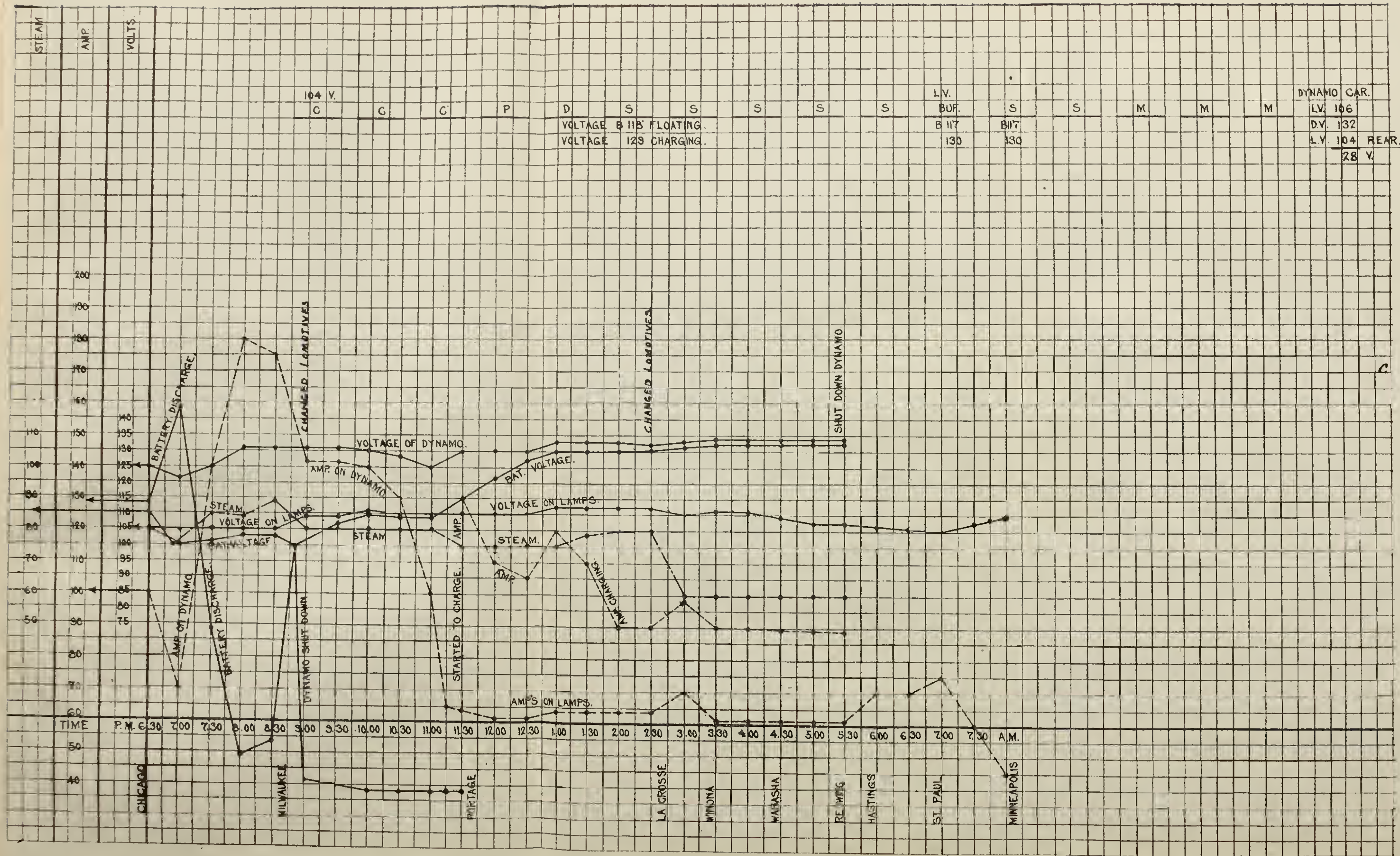

VOLTAGE
110
100
90
80
70
60
50
40
30
20
10

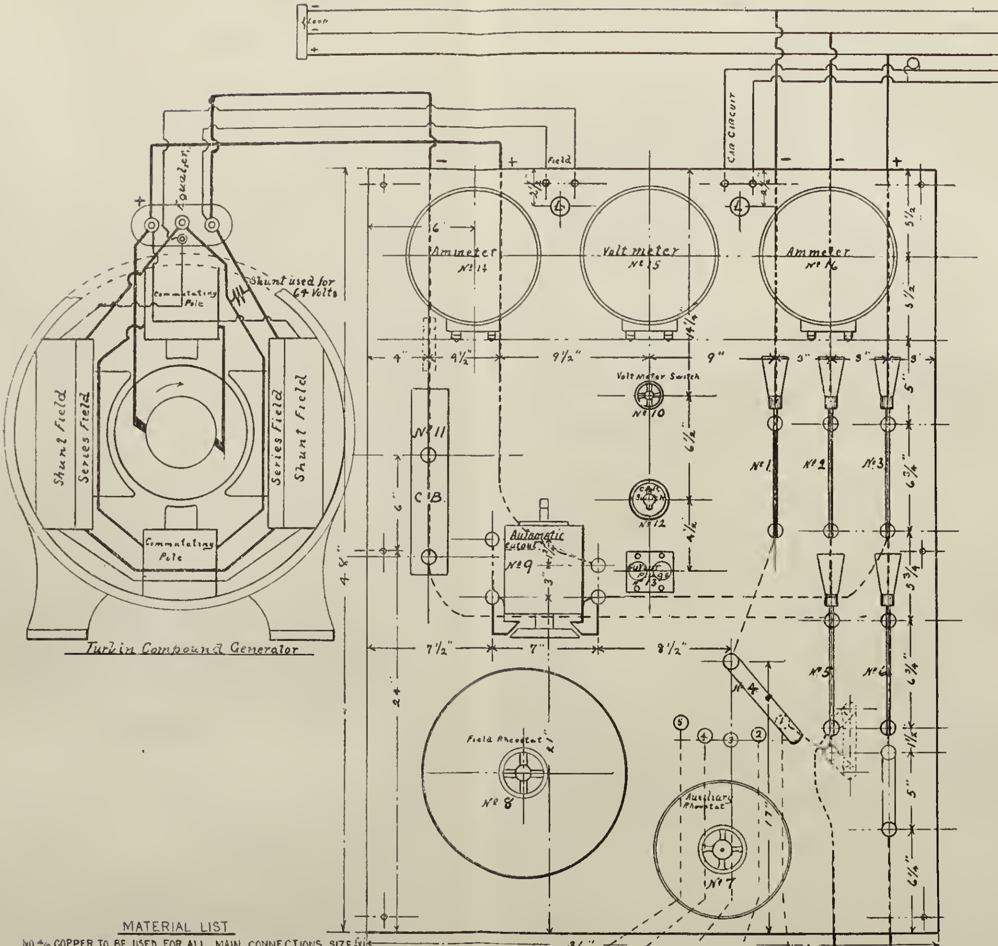
Pioneer Limited. Fig. No. 6.




STEAM
110
100
90
80
70
60
50

Pioneer Limited. Fig. No. 7.





MATERIAL LIST

NO 4/0 COPPER TO BE USED FOR ALL MAIN CONNECTIONS SIZE 1/4 X 1
1-200 TO 0.-0.TO 200 SCALE WESTON AMMETER DIRECT CURRENT
1-300 SCALE
1-125 TO 0-0 TO 125 SCALE VOLT METER
5-200 AMP S. P KNIFE SWITCHES BACK CONNECTIONS WITH LUGS & NUTS
1-10 POINT VOLTMETER SWITCH DELTA STAR MFG CO
2-1 LAMP SHORT BRACKETS WITH 1/2 TIN SHADES
1-5 POINT 100 AMP RESISTANCE SWITCH PRINT NO 125820
2-65 AMP "NOARK" FUSE BLOCKS KNIFE BLADE TYPE 2-75 AMPER FUSES
1-250 AMP AUTOMATIC BATTERY VOLTAGE SWITCH S P (BLISS CAR LIGHTING CO MILWAUKEE)
1-30 AMP PLUG CUTOUT DOUBLE POLE
1 10 AMP D P SNAP SWITCH
1 GRID RESISTANCE (TYPE NO 445) 8-GRIDS TO EACH SPACE 32 IN ALL C & H CO
BOARD TO BE MADE OF EBONY ASBESTOS 1" THICK

Resistance to be placed overhead in car

Battery Depreciation.

Battery depreciation at 15 per cent. $403.20.

Yard Labor.

While there are 40 per cent. less batteries to handle the other work on the train remains the same, so I have taken 65 per cent. of the yard cost of the 110 volt train which amounts to $360.12.

Lamp Renewals.

Forty-seven cents each is average cost of tungsten and tantalum lamps. We have figured 10 per cent. more lamps used than on the 110 volt train. Cost of lamps $2,704.85. These figures were made up about one year ago, and I now believe, with to newer lamps, we do not use any more tungsten, than carbon.

Table of Costs, 110 Volt Train.

Coal for operating dynamo	$ 830.00
Batteries, cost of hauling	4181.70
Battery depreciation 15 per cent.	679.40
Yard labor	554.80
Lamp renewals	1046.40
	$7292.30

Table of Costs, 60 Volt Train.

Coal for operating dynamo	$ 660.00
Batteries, cost of hauling	2503.80
Battery depreciation	403.20
Yard labor	360.12
Lamp renewals	2704.85
	$6631.97
Total saving by 60 volt system	$ 660.33
Total C.P. 110 volt train	6976
Total C.P. 60 volt train	10464

Taking the difference in C.P. between the carbon and tungsten and tantalum lighted train the difference is so great that one is led to think that either the carbon lamp train was poorly lighted or the tungsten and tantalum lamp train is greatly overlighted. The facts are, however, that when the carbon lamps were operated at their full 8 C.P. the lighting was very satisfactory, but as I said before, it is impossible in daily operation to get the uniform high steam pressure required to carry the heavy load required on the dynamo. With the tungsten and tantalum lamps the load was greatly reduced and even when the voltage went down below normal the extra 4 C.P. in each lamp gives a wide margin.

While the difference in operating expense is not great, the lighting service is 100 per cent. better. In fact our operating troubles have been so greatly reduced, that where we formerly received constant reports of poor lighting, we seldom if ever, now get a report of that kind.

In closing, I wish to say that the interchange of cars, on our western roads is on the increase, and a uniform voltage for the head end lighted trains is more than ever necessary, and I hope the day is close at hand when those roads that have not adopted the 60 volt system as standard will soon see their way clear to do so.

The President: The paper is now before you for discussion and I hope the discussion will be very full, and I am sure that Mr. Gilman will be very glad to answer any questions which may be raised by the members in their discussion. The paper is before you.

Mr. G. W. Cravens (Delta-Star Electric Co.): I see Mr. Gilman is getting his wish, for I noticed in a recent paper that the Harriman Lines have adopted 60 volts as their standard and that is very nearly the last of the principal roads who had not adopted 60 volts before. Mr. Gilman has been a very strong advocate of 60 volts for some time, I know, and he seems to have been justified in it, because other engineers have agreed with him in his point of view.

The saving shown here in operating expenses aside from lamp renewals, is really quite startling. As far as lamp renewals are concerned, the increased expense is undoubtedly justified by the increased illumination. We all know the great improvement in illumination due to the Tungsten lamp over the old carbon lamp, so that there is no argument necessary on that point. In general, I think the paper is very interesting and complete and I join you in hoping that the discussion will also be complete.

The President: I see the General Electric Company is represented here tonight, and Mr. Gilman has introduced them to the public. I think the General Electric Company ought to discuss this paper very fully. Of course they will not be able to say anything against Mr. Gilman's paper, but they may endorse it.

Mr. J. Scribner (General Electric Co.): Mr. Gilman came to me about two years ago, or more, and said; "Mr. Scribner, do you think it would be practicable to operate one of these machines at full ampere output, normal speed, with the generator reduced to about 60 volts or something like that?" I said: "Really, Mr. Gilman, I don't know, I will find out." So I wrote down east for information and word came back to me after a while, "Yes, we think that can be done; yes, it can be done." So I told Mr. Gilman we thought it could be done. He said, "I am glad to know that, because I have already done it." So with these two confirmations he felt justified in going ahead and finding out. I know he has been hammering away for a long time and I am glad he is getting results.

There is one point here on the 4th page where it is stated: "On this train there are three mail cars without end doors between it and the train." Now, as I remember, the night I went up with you, about a year ago, the turbine was in the fourth car back; is that right?

Mr. Gilman: Yes.

Mr. Scribner: And you got sufficient steam pressure even in the fourth car back, although it was very low, 50 to 60 pounds, so that you were able to operate the turbine, get all out of it that you wanted to, and at the same time get regulation. I do not think that could have been done with any kind of reciprocating engine.

There is another point which may be of interest. Mr. Gilman explains the slight changes he made in the machine by the adoption of an additional rheostat and a shunt across the compound field terminals. All the machines which we are turning out to-day are equipped with an extra rheostat, or an extra large rheostat, and with this shunt across the fields, so that if at any time it is desired to operate the machine on a 64-volt system, it can be done without any change. In other words, we have anticipated what all the roads will come to ultimately, and machines are sent out so that they can be operated either way and changed over at any time that may be desired.

Now, there is another point I should like to ask about. I notice Mr. Gilman uses a figure of one and one-half mills per ton mile as the cost of haulage. I have always understood from you railroad men with whom I have talked that it costs three mills per ton mile to haul equipment of any kind, and I have been under the impression that that was quite correct, because I recall Mr. Deems of the New York Central System told Mr. Young and myself, one night on a train,—perhaps Mr. Young will recall it—Mr. Deems was quite positive in the statement that it cost three mills per ton mile to haul equipment of any kind. If that is true, it seems to me that Mr. Gilman will be able to make much more saving than that shown in the figures he has submitted. In fact, it would be about two or three thousand dollars more per train per year. I do not know if there is anything further that I can add, except to congratulate Mr. Gilman on a paper that is very opportune, because the question of changing over from the higher to the lower voltage is one that has been discussed by every one connected with head end train lighting for the past five years, and the figures which Mr. Gilman gives of the cost I think are the first figures that have been put out by anybody that can be regarded as at all reliable. I thank you.

Mr. Gilman: Regarding Mr. Scribner's question with reference to the reciprocating engines, we have been able to do the same thing with the Westinghouse sets. We have thirteen of those units on our trains and while they vary more and the shunts required are

larger, we have succeeded in making them operate equally as well as turbines.

Mr. Scribner: I mean, do you get regulation of the prime mover?

Mr. Gilman: Yes, we get a good regulation.

Mr. Scribner: Have you found it necessary to readjust the engine, or to change the speed of the engine in any way?

Mr. Gilman: No, none whatever.

Mr. Scribner: To maintain the standard speed, do you change the regulating mechanism in any way?

Mr. Gilman: I will say this,—we have no engines in service on as heavy a train as here described, and that may make some difference. However, they give us good service on the trains on which we are using them.

About the baggage car running the fourth car from the engine, some time ago we had quite a disagreeable delay one night coming out of Chicago, on the "Pioneer." Through some mishap, I don't know just what, the lights all went out on the train about nine miles out of Chicago; they had to stop the train to get the baggage man back into it to find out what was the trouble. He thought he had it fixed, and after train had started and had run about ten miles further, the same thing occurred again, and they stopped the second time, consuming an hour and forty-five minutes between Chicago and Milwaukee, over the regular running time. That raised a great deal of disturbance, and on the strength of it I asked our people to put the baggage car next to the train, making it the fourth car. I had previously had a test made for a month by the baggageman in that car to see how low a steam pressure he could operate on and I found an average of 55 to 60 pounds was all that was necessary to take care of the load, so that when we put it the fourth car in the train, we had no difficulty in getting 60 pounds in the baggage car, carrying practically the same amount on the engine as we did previously when operating 110 volts.

In regard to the three mills, or one and one-half mills, I think most railroad people will agree with me that the three mills includes the handling of freight as well as the hauling, that is, it is a figure made up for the handling of dead freight over the road. Storage batteries are not handled in the sense of the word that freight is handled, so I took 1½ mills, as nearer representing the cost of hauling batteries.

The President: Mr. Crawford you have a great many figures in your head. Can you discuss that question of three mills, or a mill and a half?

Mr. J. G. Crawford (C., B. & Q. R. R.): In estimates requiring the cost of haulage of company coal I think most railroads use a rate of two mills per ton mile. This figure, of course, applies only to the cost of haulage of coal for its own use, and the method of

determining this cost would be in accordance with the following illustrative example:—

		OPERATING COST	
	Ton Miles	Total	Rate per Ton Mile
January, 1912......	110,000,000	$720,000.00	6.55 mills
December, 1911.....	100,000,000	700,000.00	7.00 mills
Difference	10,000,000	$ 20,000.00	2.00 mills

In December, 1911, in a certain territory, 100,000,000 ton miles of freight were moved at a cost of $700,000.00 or at a rate of 7 mills per ton mile. In January, 1912, every operating condition remained the same, with the exception that change in coal distribution caused 10,000,000 additional ton miles of company coal to be moved over the division, thus making the ton miles of January, 1912, 110,000,000 which were moved at a cost of $720,000.00 or at a rate of 6.55 mills per ton mile. However, this additional 10,000,000 ton miles of company coal only increased operating expenses $20,000 and therefore from the standpoint of figuring the cost of haulage of company coal, it was moved at a cost of two mills per ton mile.

The cost of haulage of storage batteries on passenger trains is somewhat different from the haulage of company coal or other company material hauled in freight service. The cost of haulage of storage batteries would be similar to the cost of hauling an additional amount of heavy express requiring little space in an express car but differs from the cost of haulage of express in the fact that it occupies no room in the car. It would seem that the only items to be considered in figuring the cost of haulage of storage batteries would be the cost of the additional power required to overcome the additional frictional resistances due to the added weight of the storage batteries, also the additional cost of maintenance of equipment due to the added weight of the storage batteries.

I am inclined to concur with Mr. Gilman that the figure 1½ mills per ton mile, which he uses as the cost of haulage of storage batteries, is very close to the correct rate.

Mr. C. E. Miller (Safety Car Heating & Lighting Co.): I want to say, in continuation of Mr. Crawford's remarks that the average cost of passenger engine service on one railroad in the central part of the country is over .86 mills per ton mile, and that the cost of freight engine service is less than .4 mills per ton mile, with coal costing $1.50 per ton on tender. The cost of passenger train service per train mile is in the neighborhood of $1.05.

It does not seem quite reasonable to me that the entire cost of passenger train service per ton or car mile, or the total cost of locomotive service per ton mile, should be used as the unit cost to compute

the expense of hauling the lighting equipment. There may be considerable difference of opinion in regard to this, but it is readily seen that such items as maintenance of way, conducting transportation, enginemen's wages, etc., do not increase on account of hauling this equipment. I believe it would be correct to charge against hauling this equipment that portion of the total cost of engine service represented by the expenditure for fuel and water. With coal at $1.50 per ton this would be approximately .3 mills per ton mile, so that on this basis, if anything, one and one-half mills is a trifle high. I thought when I saw this figure that it was an arbitrary figure a good many roads use in computing the cost of hauling company freight, and that it would be especially unfair, in view of the vast difference existing in the cost of producing high and low speed locomotive service, to use the cost per ton mile of freight service for this purpose.

I should like to ask one question in regard to the statement on the top of page 2, in which it says:

"One of the advantages of the head end system is that the number of cars put on the train to light is limited only by the number the locomotive can haul."

I was wondering if Mr. Gilman had in mind any other type of electric lighting equipment which would limit the cars it is possible to light to a smaller number than a locomotive can haul.

No, any other type. That statement would lead one to believe that there are types of electric lighting equipment with which cars might be equipped which would limit the number of cars to be electrically lighted to a smaller number than a given locomotive can haul.

Mr. Gilman: That was not the idea, but that is an expression on our road. It does not make any difference how many cars are in a train; if the locomotive can haul them, we must light them.

Mr. Miller: Your experience has evidently been different on the steam hose question than two roads I know of. The experience on the roads referred to indicates that the head end system materially reduces the life of steam hose; and for this reason the dynamo car is kept close to the tender.

Mr. Gilman: I was comparing the 110 volt system with the 60 volts in regard to that matter. When we ran 110 volts and our dynamo was loaded to capacity, we could not operate with less than 85 or 90 pounds on the machine itself, and we furnished sufficient steam besides that to operate the train, heating, which required 140 to 160 pounds on the engine in cold weather. After we reduced to 60 volts, and operated with 60 pounds of steam, we had a wide margin of steam pressure. So that we really did not carry any more pressure on our locomotive with the dynamo car the fourth from the locomotive than we used to under the 110 volt system with the dynamo car next to the locomotive.

Mr. Miller: As a matter of interest it seems to me unfortunate that Mr. Gilman did not make his comparison by including the total cost of operation, as I think the total cost of operation of a head end system would be of considerable interest.

The President: On page 8, Mr. Gilman makes the statement "We have figured ten per cent more lamps used on the 60 volt than on the 110 volt train." That is with the Tungsten lamps rather than the carbon lamps. I should like to hear that question discussed somewhat. The figures seem to me rather low. I think Mr. Lorenz of the Central Electric Co. ought to tell us all about that. He sells lamps.

Mr. Lorenz (Central Electric): I do not see any reason why the Tungsten lamps should not last as long as the carbon and even longer on the 60 volts. The Tungsten filament is a hard metal. The harder the filament gets, the greater the resistance. With the carbon lamp, the harder the filament the less resistance. Hence, the wide range of current in connection with the Tungsten lamp. But it lights the car on account of the increased resistance in the temperature in the Tungsten; a decrease in resistance in the car, with increase of temperature.

The President: Then instead of charging 10 per cent more for the Tungsten, you would charge some per cent more for the carbon?

Mr. Lorenz: There is a difference in the price, the carbon lamps come cheaper.

The President: This is due to the number of renewals.

Mr. Lorenz: Ten per cent more Tungsten light. I think that would be a good record for the Tungsten.

Mr. Cravens: I should like to ask if these figures were not arrived at before the invention of the present drawn wire filament?

Mr. Gilman: Yes.

Mr. Cravens: And the figure made before the drawn wire filament came out would be more than they would be at the present time. You say it is 10 per cent. It seems also, if that is the case, if these figures were made before the drawn wire filament came out, under present conditions, it would seem as if the reverse would be true,—it ought not to be very much higher than the carbon lamp.

The President: Mr. Pflager of the Pullman Company, can you give us any items?

Mr. C. W. Pflager (Pullman Co.): Mr. Gilman states that with Tungsten filament lamps at 60 volts the illumination of car was increased 100 per cent over that of car with carbon filament lamps at 110 volts, and it would appear that cars are now either over-illuminated or that prior to the change in voltage must have been inadequately illuminated. It is probable that lower wattage lamps might be obtained and used and make further reduction in current consumption, resulting in some additional saving and still permit illuminating the cars satisfactorily.

The President: I think Mr. Gardiner of the Burlington can tell us something of the renewal of lamps. I am sure he does not agree with Mr. Lorenz. He is sitting right beside him too.

Mr. H. A. Gardiner (C., B. & Q.): I do not know that I can say anything of interest.

The President: If you would give the same figures you gave me the other day, I think it would be interesting.

Mr. Crawford: It seems to me that this paper considers two different subjects: namely, type of filament and voltage and that these two subjects should be considered separately in the discussion. I wish Mr. Gilman's paper had covered tests of the following combinations:—

110 Volt System with Carbon Lamps
110 Volt System with Tungsten Lamps
60 Volt System with Carbon Lamps
60 Volt System with Tungsten Lamps

of course the same illumination being furnished in all cases.

It has been a good many years since I have done anything along electrical lines, and I never did very much, but if I am not mistaken there are very few what might be called "Railroad Type 110 Volt Tungsten Lamps" in use at the present time. It seems to me that the installation of new 60 volt lighting systems on the assumption that an economically successful 110 Volt Railroad Type Tungsten Lamp will never be made is just as wrong as it would have been 25 or 30 years ago to have said that there never would be a successful carbon lamp. I believe it is all right to install a 60 volt lighting system using Tungsten lamps during the development of the 110 Volt Railroad Type Tungsten Lamp, but it seems to me that the generators should be designed for 110 volts for it is only a matter of a few months before the 110 Volt Railroad Type Tungsten Lamp will be economically successful.

Both the internal and external losses will be greater in the case of a 60 volt system than in the case of 110 volt system when in each case the same total amount of illumination is furnished by lamps of the same type of filament. This means that the 110 volt system will take less coal than the 60 volt system.

The President: I think Mr. Gardiner has struck the nail squarely on the head. The standard house lighting lamp is 110 volts, and the houselighting lamp is a great many hundred times larger in number than all the railroad lamps in the country, and if the Tungsten people, or the manufacturers of a high efficiency lamp have not struck a 110 volt lamp which is perfect yet, they will before long. I think the railroads that have gone to the 60 volt lamp merely to encourage the use of a 60 volt Tungsten lamp will sooner or later go back to the 110 volt high efficiency lamp. Mr. Scribner, is that right?

Mr. Scribner: I do not want to commit myself either way.

Mr. Gilman: Mr. Chairman, it seems to me that there are a great many other things besides the lamp to think about in regard to this change. First the 110 volt system requires 22 cells of batteries *per set more* than the 60 volt system. These 22 cells weigh 3,806 lbs. and cost $462.00. In buying a large number of sets of batteries, say 50, the extra first cost would be $23,100, just for the sake of retaining the 110 volt system, because the 110 volt lamp is a standard house unit. The extra weight hauled is a large item of expense that goes on continually. The expense of handling, inspecting, refilling, and testing 22 extra cells in each set, in a large terminal yard is an extra expense that goes on indefinitely.

The difference in line and dynamo losses between a 110 and 60 volt train are not worth taking account of, because other conditions you can not control exist, namely, the varying lamp load where you are operating without batteries as is done on some trains, and even with batteries, to load up the dynamo, the varying steam pressure will cause loss of efficiency in the turbine and you can not overcome it. Outside conditions given, such as weather, good or poor coal, small failures in or about the locomotive, which all railroads have and always will have.

The President: But we all know it is a bad lamp.

Mr. Gilman: I do not agree with our worthy president. The new train Tungsten lamp is a very good one.

The President: It is of limited capacity inside.

Mr. Gilman: We ran 104 volts for a good many years, and we have found that 400 to 600 hours is about the life limit of a carbon lamp on a train; that is the limit where it is useful. It will last indefinitely, but they become so black at the end of 600 hours that they are practically useless. We have run lately a number of tests of lamps of the Tungsten types, in cars where they could be watched and the average hours has been a great deal better than 600. We had one set of lamps, nine in number, that averaged 1,100 hours in train service. I do not know whether other railroad men feel as I do, but I feel a little skeptical always about the thing that does remarkably well under conditions of that kind, and while we believe that our lamp life is entirely satisfactory, we must say that we use a few more than we did of the carbon. A serious objection to 110 volt train Tungsten lamps is the loss we would have from stealing. This was quite an item when we used carbon lamps, and with the cars scattered over a large railroad, every one in the country would have Tungsten lamps. Methods of marking and lock sockets have been proposed, but both are an expense and troublesome.

The President: I think the Illinois Central men can give us something on this subject.

Mr. E. Jenson (Ill. Cent. R. R.): I have not had any experience with head end lighted trains. We are lighting our cars by thirty

volt system of axle lighting. I would prefer, however, a sixty volt head end system rather than the one hundred and ten volt system as there would be a smaller number of batteries of larger size, which are easier to maintain. The number of connections between the cells is less than one-half.

The one hundred and ten volt head end system was adopted when carbon lamps were used and with use of sixty volt tungsten lamps the current on the mains is a little over one-third, what it would be if one hundred and ten volt carbon lamps were used, therefore the present three No. 0000 train wires are large enough as the drop in voltage is about the same.

The sixty volt Tungsten lamp will always be stronger than the one hundred and ten volt Tungsten lamp account of the filament being of greater diameter.

With one hundred and ten volts there is greater chance of the insulation breaking down in the different cars than with voltage of sixty volts.

I should like to ask Mr. Gilman if they use auxiliary gas lighting with their head end electric lighted trains.

Mr. Gilman: Yes, nearly all the cars are equipped with gas in addition to electric lighting.

The President: Mr. Squire, we have not heard from you this evening.

Mr. W. C. Squire: I should like to ask Mr. Gilman to explain the figure $67.50, on page 5, about the middle of the page. He says, "The total cost of equipping a train for this system is $67.50." Does that mean for changing the equipment over from 110 volts to 60 volts?

Mr. Gilman: That means the work done on the train.

Mr. Squire: You have already given a figure of $7.50 to cover the cost of the dynamo. Where does that $67.50 come from?

Mr. Gilman: In changing the method of charging a third main feeder had to be brought down from roof to switch box, on four cars, as stated on page 5.

Mr. Squire: Then your statement should be that the total cost of changing the equipment on this train would be $67.50.

Mr. Gilman: $67.50 and $7.50; total $75.00.

Mr. Squire: You have made a statement here that it only costs $67.50 to equip a train, but on the last page you show figures that run up into thousands of dollars for operation.

Mr. Gilman: That is right.

Mr. Squire: That means then that $75.00 covers the entire cost for the exchange between the two systems, from 110 to 60 volts.

Mr. Gilman: Yes, it means the wiring and switches needed to change the voltage of a train.

Mr. Squire: Those things ought to be cleared up, because I do not believe you want that to stand as it is.

Mr. Squire: There are some other figures here, Mr. Gilman, that I should like you to set me right on. You state in your paper that to operate on 110 volt train equipment it costs 88 pounds steam per kw. h.

Mr. Gilman: Yes.

Mr. Squire: For a 60 volt train equipment it cost you 105 pounds of steam per kw.h. You have reduced your voltage but you have increased the steam consumption per unit developed?

Mr. Gilman: The tests referred to were made by Mr. Wray a couple of years ago when he was at the University, on various trains on our road and others.

Mr. Squire: Can you explain for the satisfaction of a layman why it should cost more per kw.h. at 60 volts than 110 volts?

Mr. Gilman: The efficiency of the turbine is lower at the lower voltage on account of a smaller load.

Mr. Squire: Then, as a matter of fact, the figures are not a comparison of efficiency as regards the lighting system at 60 volts as against 110 volts, but really a comparison of the efficiency of the prime mover?

Mr. Gilman: Yes.

Mr. Squire: Then if you changed over to the 60 volt lighting proposition on new equipment you would install, to secure greater efficiency, a smaller turbine to carry the load of the 17-car train and thus cut down your cost per kw.h. to what it ought to be.

Mr. Gilman: Yes, that could be done.

Mr. Squire: Therefore you have lost by this change from 110 volts to the 60 volts quite an appreciable amount in the efficiency of the prime mover?

Mr. Gilman: Probably a small amount.

Mr. Squire: The proposition does not appear reasonable to me, because you state one place in your paper that the only limit on the number of cars to be lighted is determined by the hauling capacity of the engine. Another gentleman called attention to the fact that under those conditions it should not cost you anything for steam to light your train. As a matter of fact, you do not limit the train load to the actual hauling capacity of the locomotive, but you do determine the hauling capacity by the ability of the locomotive to make steam to meet the demands for speed, heat and light.

Mr. Gilman: Yes.

Mr. Squire: In other words, it requires a given amount of steam to operate the turbine to supply the required amount of light. This same amount of steam could be used to haul cars, say one or two, or any number. That being true the hauling capacity of the locomotive is actually reduced because of the extensive demands made on the boiler for lighting and heating. Consequently it reduces the actual capacity of the locomotive to haul cars; so that you can

have ample supply of steam for these two purposes. And as a matter of fact these two items actually cost the railroads one, two or more revenue cars. Is not this the actual condition that exists today?

Mr. Gilman: No, sir; as I said before the number of cars on a train is limited by the number the engine can haul, and we are expected to light all the cars.

Mr. Squire: On the basis shown by the figures in the paper it really costs you less for coal to operate your dynamo for the 60 volt equipment as compared with the 110 volt?

Mr. Gilman: Yes.

Mr. Squire: Then it follows if you had an efficient motor, one designed to carry the maximum load under the new conditions, you would still further reduce the fuel account?

Mr. Gilman: If the number of cars were always the same on a train, and the number of batteries the same, and one could control the steam pressure from the locomotive, we could figure the size of a turbine and dynamo to meet these conditions and have it work at its best efficiency all the time.

These conditions we can not control so we can not control the efficiency. The reason the 60 volt system showed more economical on coal, was because the average load was so much less than the load on 110 volt system.

Mr. Squire: Are the figures given at the conclusion of the paper the cost of operating the train one trip?

Mr. Gilman: No, that is for a year.

Mr. Squire: One year for one train?

Mr. Gilman: Yes.

Mr. Squire: Then it would certainly be a fair proposition in changing from the 110 volt to the 60 volt system, to throw away your large turbines and install smaller ones that would give you more efficient service, because the difference in the cost of operating would pay the interest on a very large investment?

Mr. Gilman: It would, if you could find it. There are a good many things on a railroad that are very hard to get at, and this seems to be one of them. This twenty kilowatt turbine is too large for this load to operate economically. There are times, however, when machines are loaded to their capacity. It only requires that the operating department put on a few more cars to do it. If we had a small machine, say 15 kilowatt, which would be ample for the regular train, and we put four or five extra cars on, you would be up against it, to take care of the load.

Mr. Squire: Following the argument to its logical conclusion, taking into consideration what you have just said and also one of the points you have made in your paper, which is: You have not found it possible to properly charge your batteries at the peak load period,—it actually becomes a mechanical and electrical en-

gineering problem to arrange your entire system, so that your turbine and generator can work at full maximum efficiency for a given period on the trip; storing all the excess output of current in batteries. This period, or periods, to be scheduled so that the maximum demand on the locomotive boiler shall not occur when grades are encountered or speed would be sacrificed. It being assumed for the purpose of this discussion that the battery equipment would be of such capacity to care for the excess of current output, not actually required for lighting the train. This then would be the ideal equipment and working condition you are striving for.

Mr. Gilman: It comes very near being ideal on the 60 volt train. If you look at figure No. 6 of test of 60 volt train you will see that the dynamo load was fairly constant. The earlier part of the night lighting the lamps, and the later part charging the batteries.

Mr. Squire: You make the complaint in your paper that you are not able to properly charge your batteries.

Mr. Gilman: That was with the 110 volt system.

Mr. Squire: I do not feel that you have relieved the situation. You still leave us in doubt as to what can actually be derived from this general proposition of front end lighting. Before you reply to this statement, let me ask a question which relates to the "Axle Light" systems, which derive their source of power from the car axle; each car is a separate or individual lighting plant. The generators and the controlling equipment are so designed that the excess current generated at a predetermined speed and all above, is absorbed by the batteries. Would it not be practical, in the head end system, to install a turbine and generator that would have capacity to care for the average requirements, and take care of the peak loads from the storage batteries, as is done in central station work. In this manner you could drive a small turbine and generator at their most efficient rate. Would not such condition or equipment secure high efficiency and great economy? And is it not comparable with the Axle Light System, where the excess output at high speed is stored in the batteries? Is it not possible to load your machine in the head end lighting in the same manner and get the same results?

Mr. Gilman: That is just exactly what we are doing with this 60 volt system, the excess of current goes in the batteries.

Mr. Squire: Well then, that being the case, does it not follow (and you have not stated in the figures presented) that your generator and your prime mover are doing their maximum work. You still complain of the fact that you cannot get what you want in the charging of your batteries. You state you have to wait for the passengers to go to bed to do that.

Mr. Gilman: That was with the 110 volt system. The night load on that train was 75 amperes when everything had been turned out, that was not needed. The maximum amperes of the dynamo is about 200, so if you have four batteries on the train, and they are

taking 35 to 40 amperes apiece, you cannot get it out of the dynamo in addition to the 75 amperes needed for the lights. When we went to the 60 volt train and used Tungsten lamps, the light load was reduced very materially, and after midnight, or after the sleeping car passengers are in bed, the lamp load on that machine goes down as low as 42 amperes, leaving all the excess of the machine, or 158 amperes, to charge the batteries.

Mr. Squire: Then following that same reasoning, I am still inclined to think that the electric lighting proposition is in a position where you are making extra demand on the locomotive. A railroad will have to maintain a much larger machine just to take care of the electric lights than would be necessary for hauling the train. If the contention you make is true, it would be a wiser proposition to increase your battery load, that is, increase the number of batteries carried, work your smaller turbine to its full capacity, for driving the generator all the time for a certain number of hours on each trip then cut it out for the balance of the trip and allow the lights to run on the battery. You stated a little while ago that you must have a "maximum" turbine because you did not know the number of cars that were to be run in the train. The batteries required for what is known as the "axle light" are more in number than in the head end system but as a matter of fact you must have a larger locomotive on a head end system in order to take care of the extra demand for steam. Therefore, the economy in your proposition is not very apparent.

Mr. Gilman: Batteries cost money, as you all know, and it is hard to figure some times, whether the service warrants more than a minimum number of batteries on a train.

Mr. Squire: It costs more per unit of horse power for a locomotive of a larger size than it does for a turbine generator, from what I know of the cost.

Mr. Crawford: The average life of the carbon light in train service was about 1,100 hours?

Mr. Gilman: Six hundred hours.

Mr. Crawford: Carbon 600?

Mr. Gilman: Yes.

Mr. Crawford: I misunderstood you then. You said the average life of the Tungsten lamp was 600 hours.

Mr. Gilman: The average life of the carbon lamps was 600 hours. That is, they did not break, but they became so blackened at the end of 600 hours that they were practically useless.

Mr. Crawford: Six hundred then for the carbon and how much for the Tungsten?

Mr. Gilman: I took 10 per cent less for the Tungsten lamps.

The President: Are there any further questions to be asked on this? Mr. Gilman, is there anything that you want to say in general before the meeting adjourns?

Mr. Gilman: I have nothing more to say.

The President: Mr. Gilman has given us a very valuable paper. It has meant a great deal of work on his part, but it is a distinct contribution to the data that we have on this subject and I will be glad to entertain a motion thanking Mr. Gilman for his paper.

Mr. Squire: As you have stated, Mr. Gilman has given us a very valuable paper, has brought up some data so as to make it valuable to us for data as well as other purposes. I move that this Club tender Mr. Gilman a vote of thanks.

Motion seconded and carried.

Adjourned. . . . .

THE DAVID L. BARNES LIBRARY

SPECIAL NOTICE.

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, February 20, 1912, Vice-President C. A. Goodnow in the chair.

Of those present the following registered:

Allen, G. F.
Arlein, E. J.
Barnes, C. A.
Bennett, W. A.
Bentley, W. H.
Carlton, L. M.
Connelly, W. L.
Cram, T. B.
Cross, C. W.
Derby, W. A.
Doran, H. G.
Dunham, W. E.
Endsley, L. E.
Fenn, F. D.
Forsyth, Wm.
Gilbert, H. H.
Goodnow, T. H.
Goodwin, G. S.
Hall, W. B.
Harris, T. D.
Haynes, J. R.
Hooper, B. C.
Hopkins, C. C.
Hull, G. A.
Hunter, Percival
Hyland, R. H.
Jenks, C. D.
Jennings, D. F.
Jett, E. E.
Johnson, H. A.
Johnson, J. W.
Jones, L. E.
Lammedee, J. M.
LaRue, H.
Lawrence, W. J.
Libkeman, W. A.
Lickey, T. G.
Lundehn, Otto
MacPherson, A. F.
McAlpine, A. R.
Miller, C. E.
Motherwell, J. W.
Neeley, B. J.
Parker, C. S.
Pollock, Geo.
Post, G. A.
Riddell, Chas.
Ristine, G. W.
Robb, J. M.
Rodgers, J. H.
Rowley, S. T.
Seley, C. A.
Sharp, W. E.
Slater, F.
Spiers, Andrew
State, R. E.
Stuart, J. R.
Struble, C. H.
Sweringen, F. H.
Taylor, C. O.
Taylor, J. W.
Towsley, C. A.
Vincent, M. M.
Wallace, W. G.
Walsh, W. J.
Willcoxson, W. G.
Wilson, L. F.
Winn, C. F
Woods, E. S.
Wright, Wm.

THE CHAIRMAN: Gentlemen, we will come to order, and maybe some of the delinquents who are down stairs will come up. First will be the approval of the minutes of the last meeting. They are printed and are being distributed and if there is no objection, they will stand approved as printed.

Next will be the Secretary's report of membership.

NEW MEMBERS

Name	Position.	Place.	Recommended by
F. W. Marquis, Ry. Engineering Dept., Univ. of Ill., Urbana, Ill.			E. C. Schmidt
Robert Earl, M. C. B., Kingan & Co., Indianapolis, Ind.			D. T. Harris
Charles Mallory, Supt., Kingan Car Lines, Indianapolis, Ind.			D. T. Harris
Wm. E. Shamp, Gen'l Car Insp., C., B. & Q. Ry., Aurora, Ill.			H. H. Harvey
Wesley G. Nichols, V. P., Edgar Allen Steel Co., Chicago Heights, Ill.,			H. F. Hall
R. E. S. Geare, Westinghouse Elect. & Mfg. Co., Chicago			Willard Doud
G. A. Morley, Draftsman, Mich. Cent. R. R., Ypsilanti, Mich.			C. W. Millspaugh
F. V. Tenkonohy, Draftsman, Mich. Cent. R. R., West Detroit, Mich,			C. W. Millspaugh
P. G. Hacquebart, Draftsman, Mich. Cent. R. R., Detroit, Mich			C. W. Millspaugh
C. A. Delaney, Westn. Repr. Amer. Loco. Co., Chicago			J. W. Taylor
C. W. Rhodes, Beuna Vista, Va.			J. W. Taylor
W. N. Ogden, M. B. Suydam Co., Pittsburgh, Pa			H. R. Swearer
C. B. Peck, Draftsman, A., T. & S. F. Ry., Topeka, Kan			C. P. Hill
W. J. Lawrence, V. P., R. H. Hyland & Co., Chicago			R. H. Hyland
T. H. Haggerty, C., R. I. & P. Ry., Blue Island, Ill.			R. E. State
J. P. Landreth, Mgr. Garlock Pkg. Co., Chicago			F. D. Feine
Curtis Le Feral, Loco. Engr., Belt R. R., Chicago			C. A. Barnes

MEMBERSHIP

Membership January, 1912	1617
New members approved by Board of Directors	17
Total membership	1634

The Secretary: Mr. Chairman, at this meeting the committee on the revision of the Rules of Interchange of the Master Car Builders Association should be appointed. The Board of Directors has proposed the following committee:

H. H. Harvey, G. C. F., C. B. & Q. R. R., Chairman.
C. H. Osborne, A'sst. S. C. D., C. & N. W. Ry.
W. B. Hall, M. C. B., Mather Stock Car Co.
J. W. Barrowdale, S. C. D., Illinois Central R. R.
Geo. Thompson, G. C. F., L. S. & M. S. Ry.

This committee should make its report to the Club at the April meeting.

I should like to say, Mr. Chairman, that at the March meeting we will have a paper on "Lubrication" by Dr. Conradson of the Galena-Signal Oil Company. I think you will find it a very interesting paper.

Those are all the notices I have, Mr. Chairman.

The Chairman: That being all the regular business, it brings us to the paper of the evening by Mr. C. G. Bacon, Jr., Assistant to President of the Forged Steel Wheel Company, on "Steel Wheels." Without further introduction, I will ask Mr. Bacon to come forward and read his paper.

Mr. Bacon: Mr. Chairman, I did not anticipate I would be asked to read the paper, and I am going to ask your permission to occupy the floor just a moment or two, for I have a few words which I would like to say by way of introduction.

I once heard it said that the lecturer before a Railway Club occupied a position similar to the darkey at a country fair, who stood with his head through a hole in a piece of canvas and allowed the crowd to throw baseballs at him, three balls for five cents—only the lecturer was a bit worse off, because he was not receiving pay for putting his beauty in jeopardy.

I do not feel that way, however, in appearing before you gentlemen of the Western Railway Club.

I believe that those who carry upon their shoulders the responsibilities of the great railroads of the West, themselves possess and appreciate in others that great virtue of sincerity, and though honest differences may arise which call for discussion and debate, the spirit of captious criticism is foreign to you, and that you are hearty exponents of the "square deal."

It is in that belief that I accepted the invitation to address you, and I only hope that my humble contribution to the literature of the Club will prove of interest and value.

A paper of this sort is necessarily limited in its scope. It is of course impossible to cover within such confines a subject of the magnitude and importance as that of Steel Wheels, and it is therefore desirable to select some one phase of the subject for presentation for your consideration. I have chosen the item of Standard Designs as my theme for the reason that it is most desirable, for Manufacturer and Railroad alike, that prompt agreement be reached and due recognition given to such Standard Designs as certainly seem, after careful study, to properly meet requirements.

It would be superfluous to dwell in detail upon the great financial advantage of dealing with a few standard designs,—both within a manufacturer's works and in the economical maintenance of a railroad's equipment—instead of with a multiplicity of more or less "odd" designs which may differ from such standards only in proportion to the variation in personalities of the various designs, and with little or no regard for actual necessity. If we can agree, then, upon the desirability of having standard designs, let us promptly and actively engage upon the task of deciding what they shall be, and of thereafter duly recognizing and upholding them.

And I furthermore believe that this question of designs is a particularly appropriate and interesting one for consideration at this time, since it involves at least three important features which have been widely discussed in recent months and upon which it is highly important that the attention of all should be focused, to the end that proper results shall be attained.

I refer to the features of

1—Hub Diameter

2—Rim Thickness, and

3—What I shall call mere "Dimension Wheels."

The feature of hub diameter, referred to at some length in my paper, is of importance, because it controls the dimension of the hub wall thickness of the wheel when mounted—hence it is an interesting item entering into safety, and, for that reason one which should receive the very greatest consideration. I must repeat that from the standpoint of a manufacturer I have no reason to object to enlarged hub diameters. Speaking for our own company, we can produce the enlarged hubs in a most successful and satisfactory manner, and every 25 or 50 pounds added to weight means a higher price,—with proportionately greater profit, I hope. But as one of the engineers who, back in the days of infancy of the solid steel wheel, when, primarily, as Engineer of Tests of the old Schoen Steel Wheel Company and subsequently as Wheel Engineer with the Carnegie Steel Company, had much to do with the determination and advocacy of dimensions, I would like to question the advisability of disregarding our work, on the strength of computations, or guesses, or meagre experience with a few wheels.

You have all seen cases, as I have, where the mistake is made of theorizing and of then seeking substantiation. How much better it is in all cases where possible to enter upon consideration of a problem with a free mind, and to reason from effect to cause. Why guess, or theorize, or compute, any longer as to what hub diameter should be, when the records of thousands, hundreds of thousands, of solid steel wheels which are rolling around the country answer the question in an unequivocal and irrefutable manner? What justification has a railroad official, new to the use of solid steel wheels, for edicting that 11″ hub diameter is required for 5½″ x 10″, and even 5″ x 9″ axles, when thousands of the same wheels, with 9⅞″ hub diameter, are in successful operation on neighboring roads?

Gentlemen, it is just this sort of vagary, this variation in personalities which I hereinbefore have referred to, which complicates and retards the hard, earnest work which several of us are striving to do in the direction of standardization of wheel designs. I am always open to reason, I hope, along the line of facts and figures. I have seen facts and figures which prove, by long and extensive experience, that a minimum hub wall thickness of 1¼″, or such as is provided for by a 9⅞″ hub diameter, is all that is required in connection with properly made solid steel wheels, when mounted on wheel seats up to and including 7″ diameter, and no mere theory or presumptive assertions will cause me to view the matter in a different light. An incident which has come to my notice only since I prepared my paper will interest you.

A certain manufacturer produced a few years ago quite a number of 33″ diameter solid steel wheels with 8⅝″ hub diameter, in accordance with the order of a railroad which wished to mount them upon 4¼″ x 8″ axles. A pair of these wheels was recently withdrawn from service under a tender for a defect in the tread of one of them after running somewhat over 70,000 miles, and you can perhaps imagine my feelings when I found them mounted on a 5½″ x 10″ axle, with 7″ diameter wheel-seat! Tight and true they were, though hub wall thickness was only $\frac{13}{16}''$,—and I ask skeptics to bear this evidence in mind when considering my advocacy of a 1¼″ minimum hub wall thickness.

On the matter of rim thickness I have said, and I repeat, that I really do not expect that what I have written will in itself necessarily make even one actual convert to the use of the 2½″ rim thickness in place of 3″, but I have every right to expect that in view of the very decided stand I take in this matter, any and all of you who may hold contrary opinions at the moment will at least consider that it is best to investigate and study before taking issue with me. Proof of the correctness of my attitude is rather negative in form, and necessarily so, since I am not on the defensive in this matter and will not be forced into such a position. I am not defending the use of 2½″ rim thickness. I am opposing the use of anything but 2½″ rim thickness. And if you ask me why, I will promptly reply with the question, Why is it that 3″ rim thickness is called for principally by those roads which are new to the use of solid steel wheels, or which have had but limited experience with them, and that after years of broad experience the largest users of wheels of this kind have standardized on 2½″ rim thickness?

And if that form of argument is unconvincing to you, then I say let me co-operate with you in a study of conditions on your own road, and you will soon realize the force of what I say. I cannot stand up here and quote to you the experience of the A, B, and C Railroad on this point, for instance, even though I have much of such proof in my possession, for I have been honored with the confidences of many large roads, where information has been given me in much the same way that a patient confides in a physician. I must respect these confidences, and, in urging upon you the great desirability of standardizing upon 2½″ rim thickness for solid steel wheels, I shall finally state—the "proof of the pudding is in the eating thereof," and due records of conditions on your own road will prove my position to be correct.

And, lastly, as to mere "dimension wheels." By this expression I mean such wheels as are produced under a system where there exists undue concentration upon an effort to manufacture a wheel so true to dimension that machining is unnecessary. "A man cannot serve two masters," neither can uniformity of quality be properly preserved in solid steel wheels, on a basis which

is both mechanical and commercial, if an attempt to secure mere physical dimensions in process of manufacture is to be the all-important and dominant factor.

I assume, in fact, I believe that all manufacturers of solid steel wheels can, in the ordinary course of events, produce a certain percentage, relatively small, of wheels which do not require machining to bring them to dimensions essential to good service, but I am firm in the contention that to materially increase this small percentage, or to specialize upon so doing, cannot fail to be more or less in disregard of quality. Quality, generally speaking, or uniformity of quality, specially speaking, is the keynote of success in the manufacture of solid steel wheels. Mere physical dimensions are not a part of this quality, and should not be allowed to enter in to affect it detrimentally. A man who is drunk for an entire week, sober the next week, and so on, alternately, is not as desirable a character as a man who may wish to drink in moderation at all times. The same principle is applicable to wheels. If solid steel wheel manufacture along a line which has for its principal objective the attainment of physical dimensions leads, as it inevitably does, to product which has wide variations in quality, the extremes of which are frequently mated upon the same axle, then it would seem as though the product to work for is that which, though perhaps not as good as the best nor as bad as the worst, at least possesses what is the greatest possible virtue in solid steel wheels,—the element of uniformity.

For years I have been "behind the scenes," so to speak, and I am but giving you the result of experience when I speak feelingly of the temptation, if you wish to call it such, which exists from a purely commercial standpoint, to manufacture to dimension, but I have yet to see evidence that uniformity of quality and approximate perfection of dimensions can go hand in hand in the manufacture of solid steel wheels, and so my attitude and plea to you is,—let quality, and uniformity of quality, be the items of paramount importance in manufacture, and let irregularities of physical dimensions be subsequently corrected, at a comparatively trifling cost, by machine work.

Right and logical it is that solid steel wheels are sold per wheel, per unit. They should be made on the same basis. You and I are not riding on the total of 100,000 wheels which a railroad may have in service, and therefore taking our chances on the general averages, we are riding in a car with eight or twelve units under it, and speaking, not as a manufacturer or an engineer, but purely as a man who travels many thousands of miles each year, I would like to be as sure as possible of the integrity of the units which hold my fate.

Many of you have doubtless already read the report in the current issue of the "Railway Age Gazette" entitled "The Broken Lehigh Valley Rail." In this connection and of par-

ticular importance, I earnestly commend to your consideration the editorial on the subject in the same issue. You will find therein that Mr. James G. Howard, of the Bureau of Standards at Washington, is quoted as having made the statement that

"Current railway practice in the use of hard steel rails and high wheel pressures has nearly or quite reached the limit of endurance of the metal."

I cannot speak of rails for I do not know. I can speak of wheels, for I do know. And I want to deny that railroad men have made a mistake, or even reduced the factor of safety to a minimum, in the loads they are imposing upon solid steel wheels. The only criticism which can rightly be made of them, or to speak more properly, the only suggestion of caution which can be rightly offered them, is that they should use every effort to prevent any tendency which may exist or develop to produce solid steel wheels on a mere tonnage, or "general average" basis. Again I say, with all the strength of conviction which is within me, the solid steel wheels which run under our heavy, high speed equipment should be considered as units, should be manufactured as units, and as units only. Then and then only will it be possible to maintain, in the face of searching investigation, that present wheel-loads are not excessive.

The hour that tonnage enters in at the door, individuality flies out at the window. What railroads will accept, doubtless some manufacturers will supply, but I beg of you all to carry with you my plea for Standardization in connection with solid steel wheels, particularly as regards uniformity of quality.

The paper is as follows:

STEEL WHEELS

By Mr. Chas. G. Bacon, Jr.

Asst. to President Forged Steel Wheel Co.

Able and interesting have been the papers heretofore presented to the Western Railway Club on the subject of Wheels, and enlightening indeed have been the attendant discussions. In February, 1908, and referring to the paper presented at our meeting of January 21, 1908, it was remarked how exceptional it was to find a subject which engrossed the attention of our members for two successive meetings, and which evoked such general interest. Again "Wheels" is before you, and if I am fortunate enough to suggest any new ideas, or to enlarge upon points which have been previously referred to, in such a manner as will result advantageously to Manufacturers and Railroads,—as well as, in some measure, to the "Third Party to the Contract," i. e., the Travelling Public,—I shall certainly be pleased.

One of the features of the situation which has been of great interest during the past few years, since the Solid Steel Wheel out-

grew the infant class, passed the experimental stage, and joined the ranks of full-fledged necessities, has been, and is to-day, the item of Standard Designs, and so closely interwoven with this item is that of Specifications that it is well to consider them almost as one.

The Wheel Committee of the Master Car Builders' Association was instructed by the Executive Committee, shortly after the Convention at Atlantic City, last June, to consider these items of Designs and Specifications, and to report thereon at the convention to be held this coming June. I do not believe that I am divulging any confidence when I state that the Wheel Committee held a meeting somewhat over two months ago at which were present, by invitation, representatives of the Solid Steel Wheel Manufacturers, in the hope that they would assist the Committee in its arduous work. This, in my opinion, was a splendid move in the right direction. The interests of Manufacturers and Railroads are identical. One hears and reads how, in times past, when volunteer fire departments were the rule, even in large cities, the members of rival companies disputed and fought for the questionable honor of who "saw it first" or who "wet it down," while all the time the fire might blaze merrily on, destroying property and oftentimes life,—but, happily, such days are past, and we see, instead, splendid units of thoroughly organized departments going forth to co-operate in work which is for the benefit of all. Surely it is not expecting the lion and the lamb to lie down together to ask Manufacturers and Railroads, or vice versa, to co-operate and agree upon what is best for the interests of those they serve, and the Wheel Committee of the Master Car Builders' Association is upholding all the best traditions of its organization when it joins hands with the manufacturers of Solid Steel Wheels in an effort to develop the best possible material and to thus safeguard the hundreds of thousands, yes, millions, of lives which are in a measure in its keeping.

Upon learning that the subject of Specifications covering Solid Steel Wheels had been under consideration for upwards of two years by a special committee of the American Society for Testing Materials, the M. C. B. Wheel Committee very promptly, and wisely in my opinion, determined to accept an invitation which was extended, to have representation on the A. S. T. M. Committee. This latter committee is certainly well qualified and privileged to handle this important item intelligently,—being composed of representatives of the Manufacturers and of the Railroads which have had the longest and most extensive experience with Solid Steel Wheels. As I am a member of this Society for Testing Materials Committee, —as its labors are not yet completed,—and as its co-operative work with the M. C. B. Wheel Committee is still under way, it would be highly improper to divulge its proceedings, but there is certainly no reason why I should not say, right here and now, that the results of

the committee's work should be viewed seriously and with respect by all. It is not to be expected, in a vast and important matter of this kind, that results obtained will, in detail, meet the ideas, wishes, or even requirements perhaps, of all. There are too many conflicting interests to be reconciled,—too many points on which there may be honest differences of opinion,—and, on some points, too little data available, to render results as actually ideal,—yet it is a decided step in the right direction, and will give a standard, or recognized basis to work upon, which can be amended and developed from time to time in future so as to serve the greatest good of the greatest number.

As regards the question of designs, it is but right and proper that the question be thrown open to all, so that there may be full expression of opinion, and so that Manufacturers and Railroads will reach agreements, or standards, at the earliest possible moment. It is, then, the object of this paper to lay before you a list of twenty-one (21) designs of Solid Steel Wheels which long experience and careful study would seem to indicate are adequate standards in connection with more than ninety per cent. (90%) of the requirements of the railroads of the United States today, and which would soon cover the other ten per cent (10%) if railroads would give attention to some points in connection with co-ordinate equipment. —and to further lay before you certain reasons why study of the subject has convinced me that a total of eleven (11) of these designs are all that are desirable or required. I ask the fullest possible consideration of the designs which form a part of this paper,—I ask Railroad Officials to carefully compare them with their present drawings, with the idea of noting differences (if any),—and I believe that a full and free discussion, thereafter, cannot fail to be of great mutual advantage.

Figs, 1 to 8, inclusive, show types of Wheels for Engine Trucks, and Figs. 9 to 21, inclusive, show types for Freight Cars, Tenders, and Passenger Train Cars,—the salient point of difference between these two general classes being that Wheels for Engine Trucks require inside hub faces of large diameter in order to provide adequate bearing surface as against Journal Boxes.

The total of eleven (11) designs which I think are all that are desirable and required, are—

ENGINE TRUCKS.

Fig. 1............	28½″	diameter
Fig. 2............	30″	"
Fig. 4............	33″	"
Fig. 7............	36″	"

FREIGHT CARS—TENDERS—PASSENGER TRAIN CARS.

Fig. 9............28″ diameter
Fig. 10............30″ ‘‘
Fig. 13............33″ ‘‘
Fig. 15............33″ ‘‘
Fig. 17............36″ ‘‘
Fig. 19............36″ ‘‘
Fig. 21............38″ ‘‘

One of the reasons which enters in to increase the number of Designs of Wheels for Engine Trucks above the four (4) above noted is that of diameter of inside face of hub. It has long been considered and determined by prominent railroads, who have placed many thousands of Solid Steel Wheels in Engine Truck service, that this dimension should properly be 12 5/16″,—but there have recently been several large companies who have called for Engine Truck Wheels with inside hub faces of either 13″ or 14″, and in fact one large system has issued a sheet setting forth that this dimension shall be either 11″, 12″, 13″, 13½″ or 14″, under certain conditions. I venture to say that ninety-five per cent (95%) of the Solid Steel Wheels which are in Engine Truck service in the United States to-day have 12 5/16″ diameter of inside hub face,—this dimension is standard with the roads which have had the longest and most extensive experience with Solid Steel Wheels of this type,—I am told that it has proven to be a proper and satisfactory dimension,—and I therefore wish that all railroads would agree either upon this diameter of 12 5/16″, or at least some one diameter, as being the standard dimension. The cost of manufacturing Solid Steel Wheels, and therefore the price to the railroads, is largely a question of the number of wheels produced per type, and this being the case it seems most important,—particularly as regards Engine Truck Wheels, of which the total number required is not sufficiently large to enable manufacturers, even under the best of conditions, to reduce cost of production to the same level as that of the other classes of which larger quantities are used,—that specific attention and study should be given to this dimension of inside hub face diameter, so that a Standard can be adopted for the best interests of all concerned.

The 33″ wheel per Fig. 15 differs from the 33″ wheel per Fig. 13, and the 36″ wheel per Fig. 19 differs from the 36″ wheel per Fig. 17, to only the extent required by the adoption of an additional M. C. B. Standard Axle,—i. e., the 6″ x 11″. Hub length is necessarily increased from 7″ to 7½″,—depression of front face of hub from 15/16″ to 1 3/16″,—and projection of inside face of hub from 2 7/16″ to 3 3/16″. Also, and more particularly, hub diameter is increased from 9⅞″ to 11″, in order to provide due hub wall thickness.

This brings to mind a point which I wish to make one of the principal features of my paper,—i. e., as to what is the proper hub wall thickness for Solid Steel Wheels.

A hub diameter of 9⅞″ has long been recognized as all that is required in mounting Solid Steel Wheels upon 4¼″ x 8″, or 5″ x 9″, or 5½″ x 10″ axles,—i. e., up to and including 7″ diameter wheel-seats,—for even in connection with 5½″ x 10″ axle, and allowing for the tolerances for eccentricity provided for in Specifications, a 9⅞″ hub diameter means a minimum hub wall thickness of 1¼″ on a 7″ diameter wheel-seat. During the past few months, and under the leadership of one of our large systems, which, however, is basing its statements and acts upon experience with comparatively few Solid Steel Wheels, there has been quite a move on the part of some railroads (none of those which have had long and extensive experience in the matter, however), to use wheels with 11″ hub diameter on 5½″ x 10″ axles, and even on 5″ x 9″ axles, on the ground that 1¼″ was not sufficient for a minimum hub wall thickness and tended to "loose wheels." From a manufacturer's standpoint I have no reason to take exception to this move. A heavier wheel means a higher price, and so long as a railroad wishes to pay for excess metal I do not know that it is within a manufacturer's province to object. But as one of the engineers who has had to do with the Solid Steel Wheel subject from its infancy, and who is more or less responsible for the determination and advocacy of dimensions, I wish to assume just as definite and positive an attitude on this point as words will permit me to express.

I have long been in touch with this particular point and have had vast personal experience in the boring and mounting of wheels, and since this question was raised, recently, I have made a further study of it and consulted with some of those railroads who are qualified by long and extensive experience to speak definitely and intelligently on the subject.

I find that one large system, having over 200,000 Solid Steel Wheels in service, has had less than a dozen "loose wheels" in the past six or seven years,—despite the fact that 1¼″ minimum hub wall thickness has been adopted practice, and despite the fact that in the early days of the Solid Steel Wheel industry, when manufacture was not as accurate in some ways as at present, many wheels went into service with 1⅛″ hub wall thickness. And of still greater interest, perhaps, is the fact that close investigation of each one of these few cases of "loose wheels" developed the fact that the trouble was due, solely and entirely, to improper boring and mounting, in some detail, and had no reference whatsoever to the wall thickness of the hub of the wheel. From another large system, with upwards of 90,000 Solid Steel Wheels in service, I learn that in six or seven years only three or four cases of "loose wheels" have developed, despite hub wall thickness of 1¼″ mini-

mum, and that investigation of these few cases showed them to be due to improper boring and mounting, also.

Such being the experience of those whose long and extensive use of Solid Steel Wheels certainly qualifies them to know whereof they speak, and the knowledge of those whose grasp of the wheel subject entitles them to assert, I must say that I look upon it as a piece of undue assumption when a railroad with a limited experience, both in time and in quantity, sets out to be aggressive along a line with which it is unfamiliar,—and I want to say, as forcefully as I can, that hub wall thickness of 1¼″ is all that is required in connection with properly designed and manufactured Solid Steel Wheels when mounted on axles with wheel-seats up to and including 7″ diameter, and to state that those who are troubled by "loose wheels" under such conditions must look to their own shop practices, to their boring-mills, their axle-lathes, and their wheel-presses for the reason, for the wheel is not responsible for the trouble which some may find in this particular.

Though included in the list of drawings, I would hope that 33″ wheel per Fig. 14 and 36″ wheel per Fig. 18 could be eliminated from consideration as Standard Designs. There are some roads who, in wishing for something larger than 5½″ x 10″ axle, have for reasons of their own doubtless, neglected to adopt the M. C. B. Standard 6″ x 11″, and have gone to the use of sort of an "in-between,"—6″ x 10″,—which renders it necessary to add these two extra designs of wheels, per Figs. 14 and 18. As I am discussing wheels I do not like to encroach upon another subject, but it seems to me that as much axle trouble is caused by over-heating as by lack of section, and that conditions are not much improved, therefore, by increasing section without proportionate increase in bearing. In other words, is there any great advantage in a 6″ x 10″ axle over a 5½″ x 10″ axle,—would not logic dictate, as a step in advance of the 5½″ x 10″ where necessary, the adoption of the 6″ x 11″ axle, instead of a mere "in-between?" I refer to this as merely another one of those features which has its effect upon the cost of manufacture, and therefore the price to the railroads, of Solid Steel Wheels,—and, in consequence, as one which is deserving of consideration from an economic stand-point.

Another point which I desire shall be one of the principal features of my paper is brought up by the suggestion that, though shown as Standard Designs in the list of drawings submitted, I would like to eliminate 30½″ Engine Truck Wheel per Fig. 3, 33½″ Engine Truck Wheel per Fig. 6, 33½″ wheel per Fig. 16, and 36½″ wheel per Fig. 20,—and my reason for wishing and hoping to see these designs eliminated is solely and entirely because they mean the use of Solid Steel Wheels with 3″ rim thickness.

This subject of rim thickness is one which has received much study and attention at my hands for several years and all experi-

ence tends to prove that 2½″ rim thickness in connection with Solid Steel Wheels makes for efficiency and economy, and that the use of 3″ rim thickness is to be avoided.

There are two ways of looking at this matter,—both of which, however, lead to the same result. In the first place,—one must consider the rim of a Solid Steel Wheel as being of two general parts, so to speak,—(1) the allowable wearing-body, being that depth which can be properly used in service, and (2) the minimum allowable rim thickness, which necessitates removal from service. For example,—in a rim thickness of 2½″ it may be said that there is 1½″ of allowable wearing-body, with 1″ thickness remaining which calls for removal from service under M. C. B. Rules. Going a step further, it must be borne in mind that this 1½″ of allowable wearing-body cannot be entirely used in road service. From time to time while the wheel is in service certain deformations of contour will occur, after varying mileages (and with correspondingly varying depths of metal worn from tread), which necessitate removal of the wheel from service, for re-machining to restore due contour (meaning a depth of metal removed from tread, again, in this operation). All conditions are so variable that it is impossible to say definitely what depth of tread is worn off before the first re-machining, then what depth of metal is removed in that re-machining, and so on, during the several periods, you may say, constituting the total depth of allowable wearing-body,—but long experience, with general averages on numerous and various railroads, and under varying conditions, enable me to say that the allowable wearing-body in a rim 2½″ thick will split-up far more economically than the wearing-body in a 3″ rim,—or, to put it another way, that, as a general average proposition, a railroad will secure more actual sixteenths of an inch of wearing-body, and fewer sixteenths of an inch of waste metal, in the allowable wearing-body of a 2½″ rim than in a 3″ rim. And though this broad statement of fact may seem to over-shoot the mark, and to evoke remonstrance from those who have not given the point specific attention, all I ask is the opportunity for co-operative study with any railroad official of conditions on his own road, and I will be able to clearly demonstrate the correctness of my statement. But, in the second place,—to properly meet conditions a Solid Steel Wheel should possess, throughout the depth of its allowable wearing-body, an attrition-resistance equal to that of the rail, and, to obtain this, certain limits must be recognized in rim thickness from a manufacturing stand-point. Not alone must a high degree of attrition-resistance be obtained initially, but it should be maintained, as uniformly as possible, throughout the allowable wearing-body,—and this quality is largely secured by the work, and the depth of penetration of the work, which is put upon the rim. I contend that there is no process of manufacture of Solid Steel Wheels known to-day which will produce as good and serviceable a wheel with 3″

rim thickness as with 2½″ rim thickness, and I am, furthermore, making a statement based on the records of a good many thousands of wheels which have been worn out in service when I emphasize this by making the statement in another way,—i. e., the mileage-life of a Solid Steel Wheel with 2½″ rim thickness is greater than one with 3″ rim thickness, all other things being equal. To look at this point in another light. I have always been, and I am to-day, a strong and consistent opponent of the use of the term "shelling" in connection with Solid Steel Wheels. There has been too much of a tendency to call all defects "shelling," owing to either convenience or lack of familiarity with the subject, whereas due and proper analysis would have classed the defect under one of three or four other and more specific headings, which would have enabled the manufacturer to handle the matter far more intelligently and in a manner decidedly more for the benefit of the railroad. "Shelling" may be the easiest thing to think of, or to say, but it is absolutely non-specific under normal conditions in connection with Solid Steel Wheels, and, in ninety-nine cases in a hundred, means nothing at all. It was explained to me, years ago, by an old and prominent Cast-Iron Wheel Manufacturer, how the term "shelling" originated, and as I remember it his explanation was this. The chilled portion in the rim of a Cast-Iron Wheel extends at a right-angle to the chill-block, and only to a certain depth,—this depth being dependent upon the quality of the iron, etc.,—the effect being that there is a slight depth of metal with strong resistance, backed with ordinary gray iron of far less resistance, bordering, comparatively speaking, upon sponginess. That when this strong surface metal had been worn so thin as to be unable to support the service-load which was upon it, it would, having but a comparative sponginess or cushion beneath, mash-up and fall away in a manner which left the appearance of the outside of an oyster shell, and hence the term "shelling." With this explanation in mind I have always been opposed, as stated, to the use of the term "shelling" as applied to Solid Steel Wheels, for I have believed, and my belief has been based on specific study, that no such condition should exist in properly designed and made Solid Steel Wheels. But I must now go on record as saying that if some railroad officials persist in using wheels with 3″ rim thickness, or over, and can succeed in inducing manufacturers to supply such types, then I must, though most regretfully, add the item of "shelling" to the liabilities of Solid Steel Wheels,—for close observation of many wheels of this type, not confined to any one manufacturer's product, which I have investigated, convinces me that in a properly made Solid Steel Wheel with 2½″ rim thickness there is good opportunity for knowing what you are getting, whereas with 3″ rim thickness you cannot be sure of anything, except that there will be a considerable percentage of dis-satisfaction and trouble in the results you obtain. Let those who doubt the correctness of my posi-

tion in this matter take heed of the fact that the railroads who have had the longest and most extensive experience with Solid Steel Wheels have nearly all given up the use of Solid Steel Wheels with 3″ rim thickness and adopted 2½″ rim thickness as Standard,—let them note the fact that the more a man learns about the Solid Steel Wheel subject the more convinced he becomes that 2½″ rim thickness gives the best and most economical results, as is pretty well evidenced by the abolishment of the use of 3″ rims on his road and the substitution therefor of 2½″ rims by a member of the M. C. B. Wheel Committee, since he has come to have a more thorough knowledge of the subject,—and let any official refer to the records of his own company and see if the facts of the case do not thoroughly verify my statements.

My line of argument must not be construed, however, to mean that a 2″ rim thickness would be more efficient and economical than a 2½″ rim thickness. I do not mean that, and I do not believe that. The 2″ rim thickness does not lend itself to economical division of allowable wearing-body to meet periods of road service, and metal lost in re-machining,—neither does it afford the manufacturer full opportunity for his best work. In this question of rim thickness one is not forced to consider extremes and reluctantly adopt a compromise average, in acknowledging that 2½″ rim thickness is desirable in connection with Solid Steel Wheels,—one need only indulge in a bit of self-congratulation that all manufacturing conditions and service requirements unite in identifying 2½″ rim thickness as both efficient and economical.

One more point, which I desire to make a special feature of my paper, is a word of caution regarding the production of wheels without machine work upon them.

For years I have been an advocate of the idea of producing wheels so true to dimension that machine work was reduced to a minimum, and I doubt if there is any other one man who has introduced as many wheels of this type into service as I have. I am still a firm believer in the theory, but only to the extent to which it can be carried in due justice to the quality of the material produced. Machine work increases cost of production,—machine work may often times remove metal of particular service value,—yet if the effort to produce material on which machine work is unnecessary opens the door to a product which lacks uniformity, lacks many of the other virtues which it should possess, and borders on the dangerous,—then I feel that extreme caution should be used in order that a "penny wise, pound foolish" policy can be avoided. It may be all right enough to produce some of the commodities of life on the basis of tonnage, or general average,—probably it is,—but in dealing with wheels let us not forget that we are dealing with units, each and every one of which should possess integrity, as otherwise much time will be spent in settling claims for low mileage, in providing

for adjustments covering defective material, and, worse yet, in explaining how wrecks occurred.

Uniformity in manufacture is perhaps the feature most to be desired in connection with Solid Steel Wheels. But uniformity of quality should be held as paramount to uniformity of mere dimensions,—and when the tendency is to sacrifice uniformity of quality in the effort to obtain uniformity of dimensions, then I believe that the time has come to "stop, look and listen."

The production of proper Solid Steel Wheels does not entail the mere forming of a bulk of steel into the shape of a wheel. It carries with it far greater requirements and responsibilities. Proper production means not alone mere shaping, but, and particularly, the working into shape along such lines as tend to preserve and develop the virtues of the material for the service in which the finished product is to be used, and the doing of this in such a way as assures uniformity of quality as between wheels which are subsequently mated in service. Irregularity of dimensions can be easily overcome by a few pennies worth of machine work, but lack of uniformity in quality is incurable, so as to speak, and is sure to assume more or less serious, if not actually dangerous, forms, when the wheels go into service. I speak most feelingly on this point, for it is one with which I have been closely identified for years,—it is one which I have seen, over and over again, is of grave importance,—and because it is one which should be closely watched and studied by railroad officials.

I again ask, in conclusion, your consideration and criticism of these 21 designs of Solid Steel Wheels which I suggest as standards for the steam railroads of the United States, and I particularly ask both your earnest consideration and thoughtful criticism of the arguments I have advanced for a desire and suggestion that the list be reduced to a total of eleven (11) designs.

Manufacturers of Solid Steel Wheels are particularly accommodating when engaged in close competition for a railroad's order, and it is for that reason that wheels of all sorts and sizes can be obtained. But clear-headed railroad officials certainly realize that the production of small quantities of an endless variety of designs means a higher cost than when a minimum number of designs permits of proportionately larger quantities, and that cost is always reflected in price. They certainly realize that in the heat of close competition a sales department will frequently offer, because the works says under urging that they can produce, "odd" designs which may or may not have been thoroughly demonstrated as unifying the possibilities of proper manufacture and the requirements of service, and they surely appreciate how standardization of wheel designs is an end to which we all should strive.

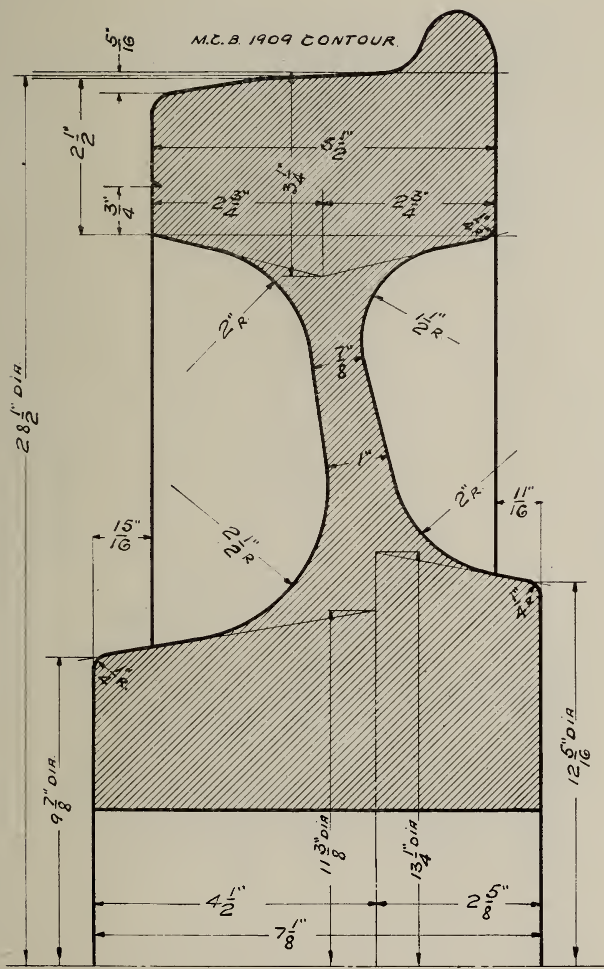

M.C.B. 1909 CONTOUR
$28\frac{1}{2}$" DIA.
$9\frac{7}{8}$" DIA.
$11\frac{3}{8}$" DIA.
$13\frac{1}{4}$" DIA.
$12\frac{5}{16}$" DIA.
$4\frac{1}{2}$"
$2\frac{5}{8}$"
$7\frac{1}{8}$"
$5\frac{1}{2}$"
$3\frac{1}{4}$"
$2\frac{1}{2}$"
$2\frac{3}{4}$"
2" R
$2\frac{1}{2}$" R
$\frac{7}{8}$"
1"

Fig. No. 1

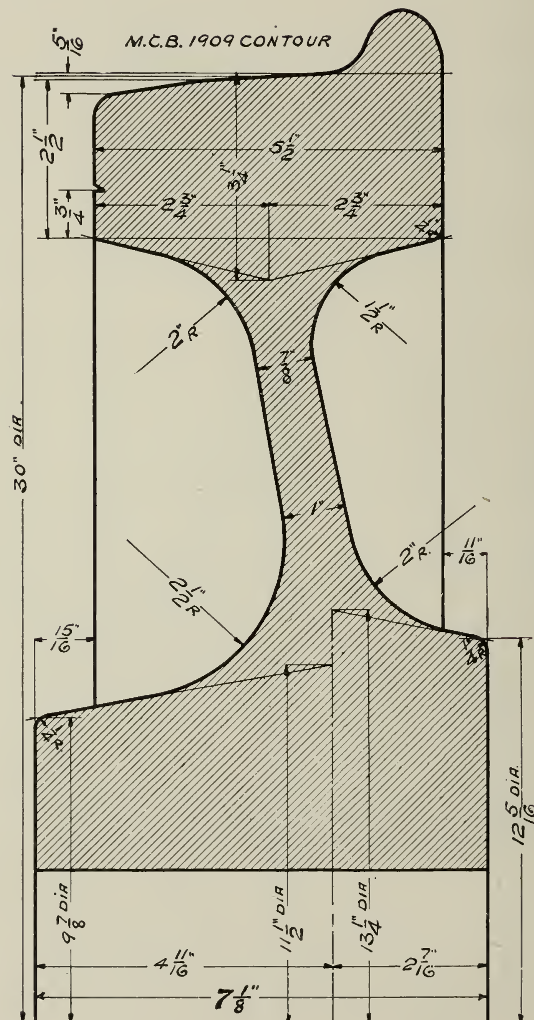
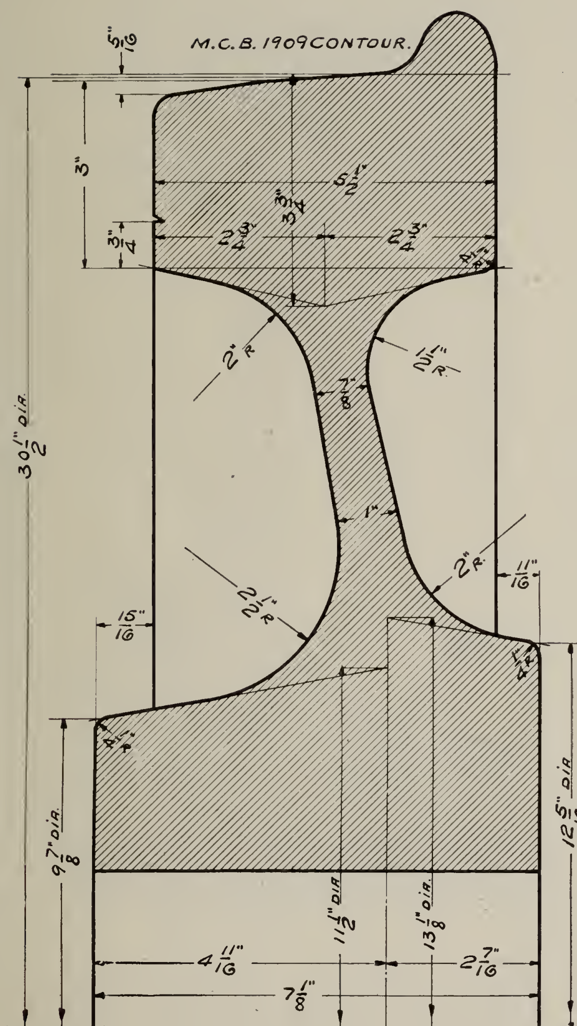


Fig. No. 2



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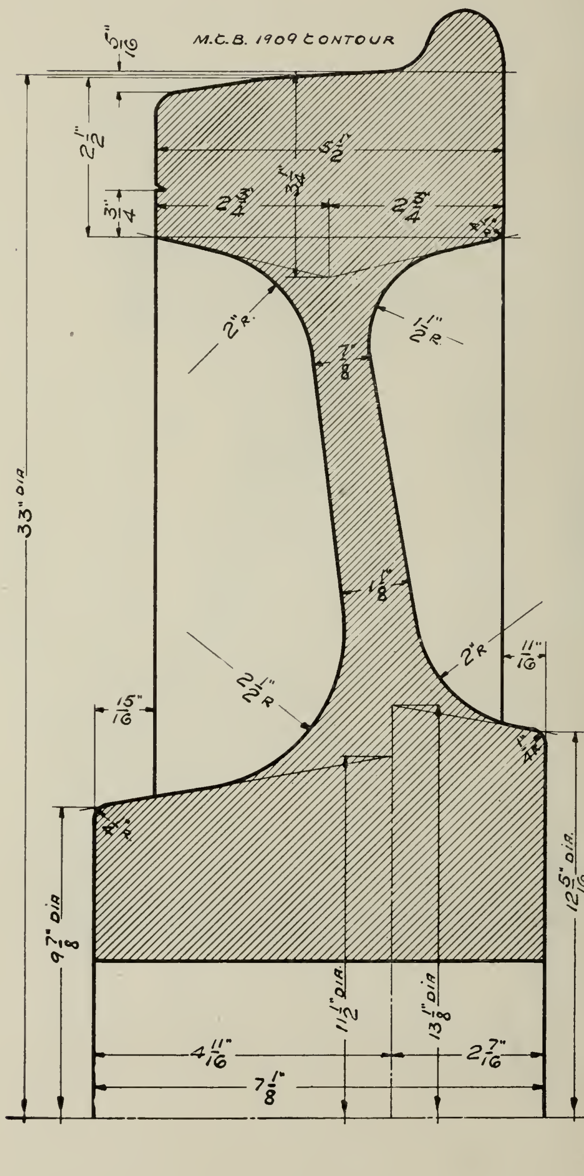

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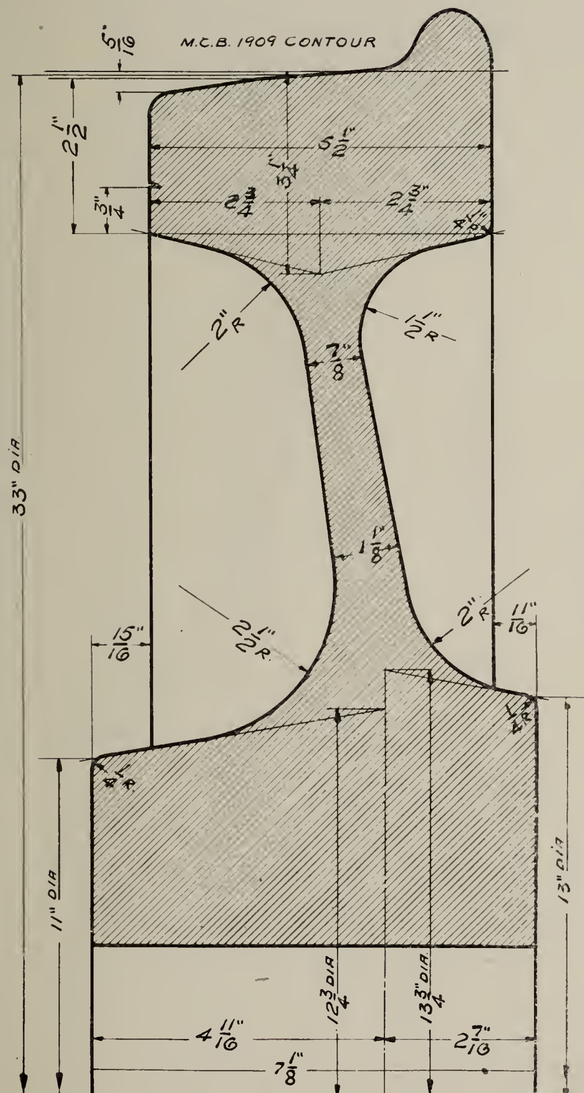

M.C.B. 1909 CONTOUR
33" DIA
11" DIA
13" DIA
$12\frac{3}{4}$ DIA
$13\frac{3}{4}$" DIA
$5\frac{1}{2}$"
$2\frac{3}{4}$
$2\frac{3}{4}$"
$2\frac{1}{2}$"
$\frac{3}{4}$"
$\frac{5}{16}$"
2" R
$1\frac{1}{2}$" R
$\frac{7}{8}$"
$1\frac{1}{8}$"
$2\frac{1}{2}$" R
2" R
$\frac{11}{16}$"
$\frac{15}{16}$"
$4\frac{11}{16}$"
$2\frac{7}{16}$"
$7\frac{1}{8}$"

Fig. No. 5

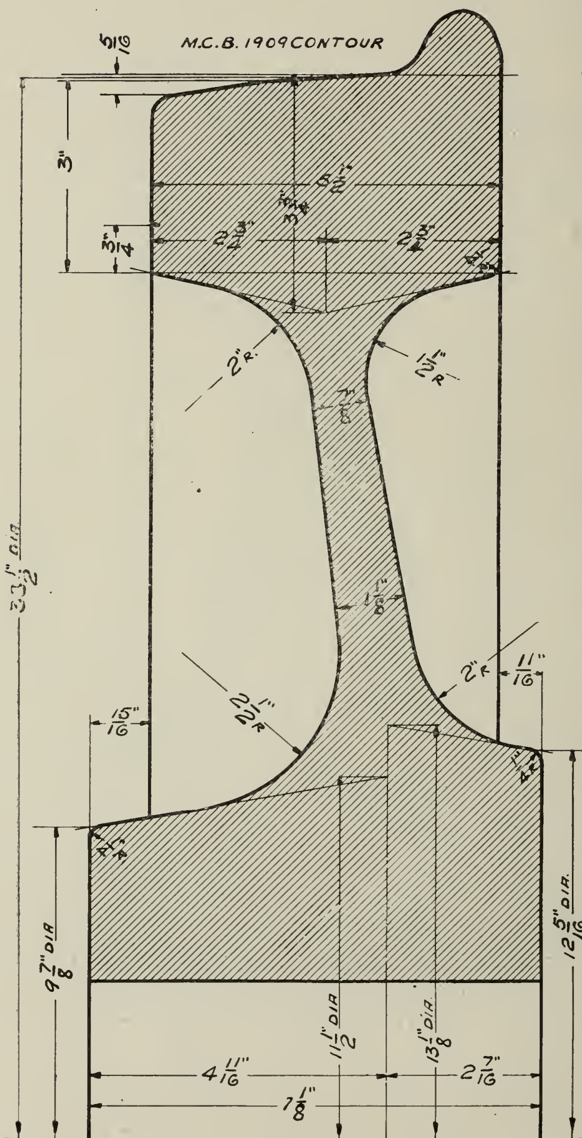


Fig. No. 6

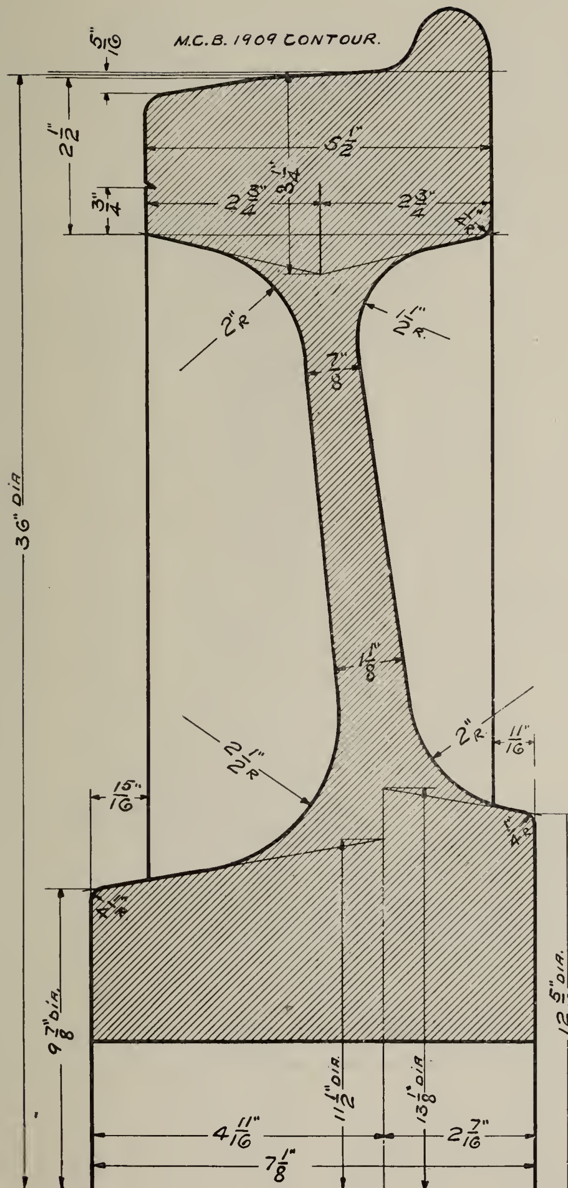

M.C.B. 1909 CONTOUR.
36" DIA
9 7/8" DIA.
12 5/16" DIA.
11 1/2" DIA.
13 1/8" DIA.
4 11/16"
2 7/16"
7 1/8"
5 1/2"
2 3/4"
3 1/4"
2 1/2"
2" R
2 1/2" R
7/8"
1 1/8"
15/16"
11/16"

Fig. No. 7

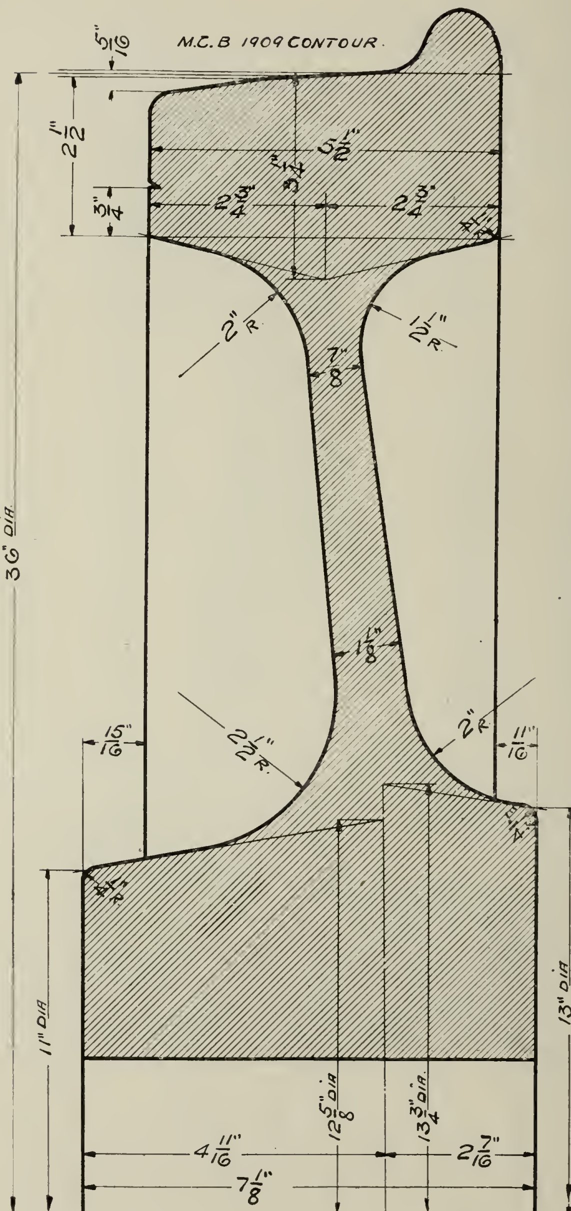

M.C.B 1909 CONTOUR.
5/16"
2 1/2"
3/4"
5 1/2"
3 1/4"
2 3/4"
2 3/4"
2" R
1 1/2" R
7/8"
1 1/8"
2 1/2" R
2" R
15/16"
11/16"
36" DIA
11" DIA
13" DIA
12 5/8" DIA
13 3/4" DIA
4 11/16"
2 7/16"
7 1/8"

Fig. No. 8

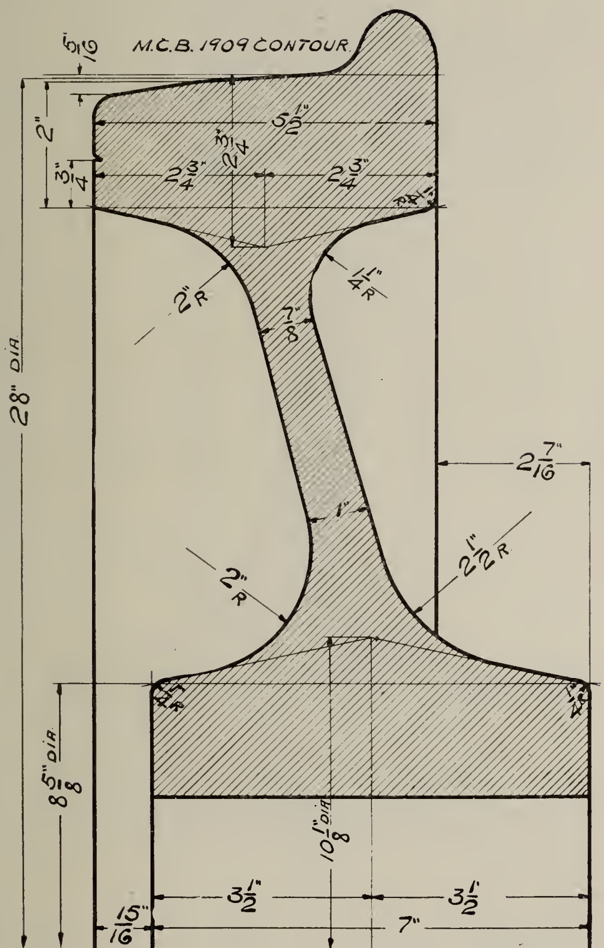

M.C.B. 1909 CONTOUR
28" DIA
$8\frac{5}{8}$" DIA
$10\frac{1}{8}$" DIA
$5\frac{1}{2}$"
$2\frac{3}{4}$"
2"
$\frac{3}{4}$"
$\frac{5}{16}$"
$\frac{7}{8}$"
1"
2" R
$1\frac{1}{4}$" R
$2\frac{1}{2}$" R
$2\frac{7}{16}$"
$3\frac{1}{2}$"
7"
$\frac{15}{16}$"

Fig. No. 9

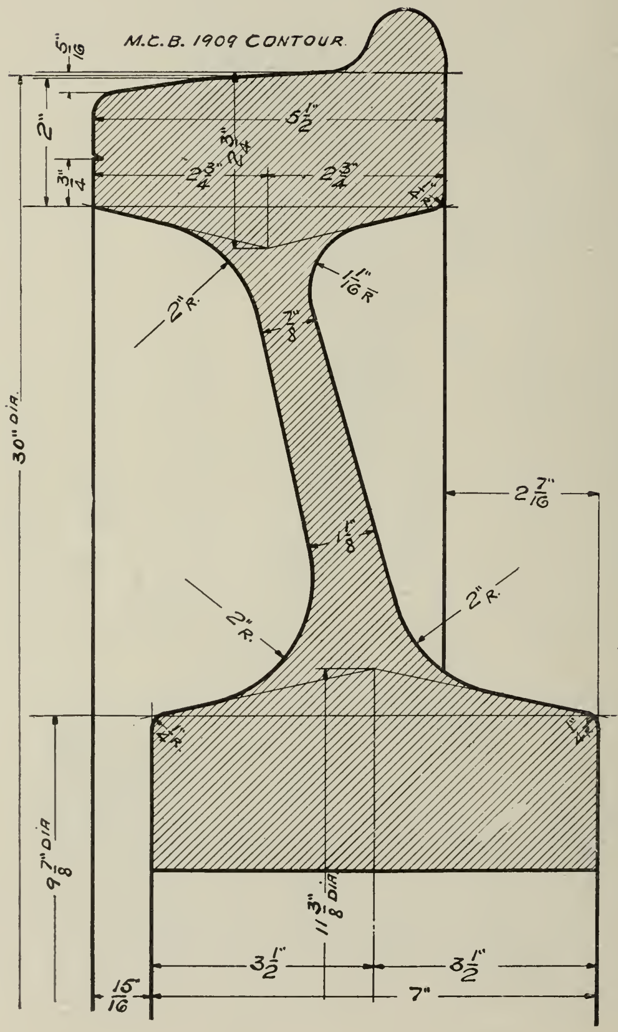

M.C.B. 1909 CONTOUR.
5"/16
2"
3"/4
5 1/2"
2 3/4"
2 3/4"
2 3/4"
2" R.
1 1/16" R
7/8"
30" DIA.
2 7/16"
1 1/8"
2" R.
2" R.
9 7/8" DIA
11 3/8" DIA
3 1/2"
3 1/2"
7"
15/16

Fig. No. 10

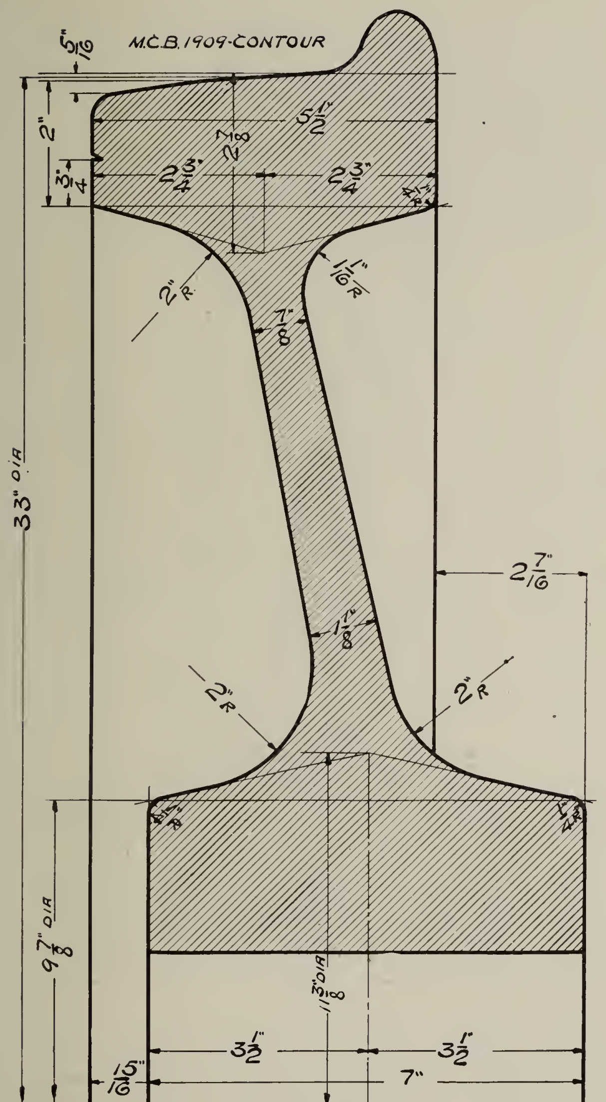

M.C.B. 1909-CONTOUR
5/16"
2"
3/4"
2 7/8
5 1/2"
2 3/4"
2 3/4"
1/4" R
2" R
1 1/16" R
7/8"
33" DIA
2 7/16"
1 1/8"
2" R
2" R
1/4" R
1/4" R
9 7/8" DIA
11 3/8" DIA
3 1/2"
3 1/2"
15/16"
7"

Fig. No. 11

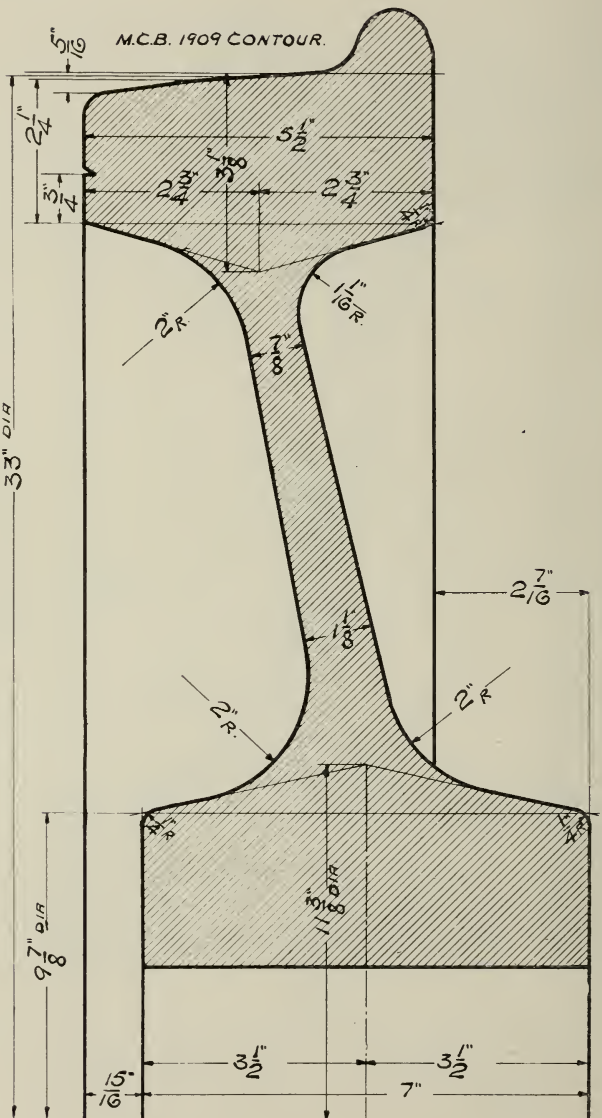


Fig. No. 12

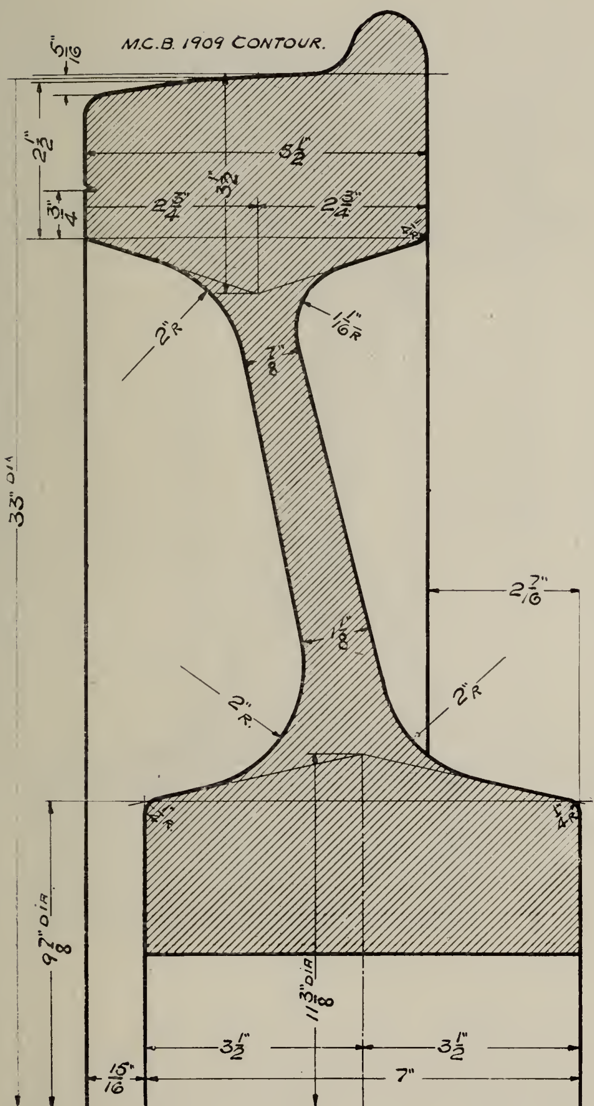


Fig. No. 13

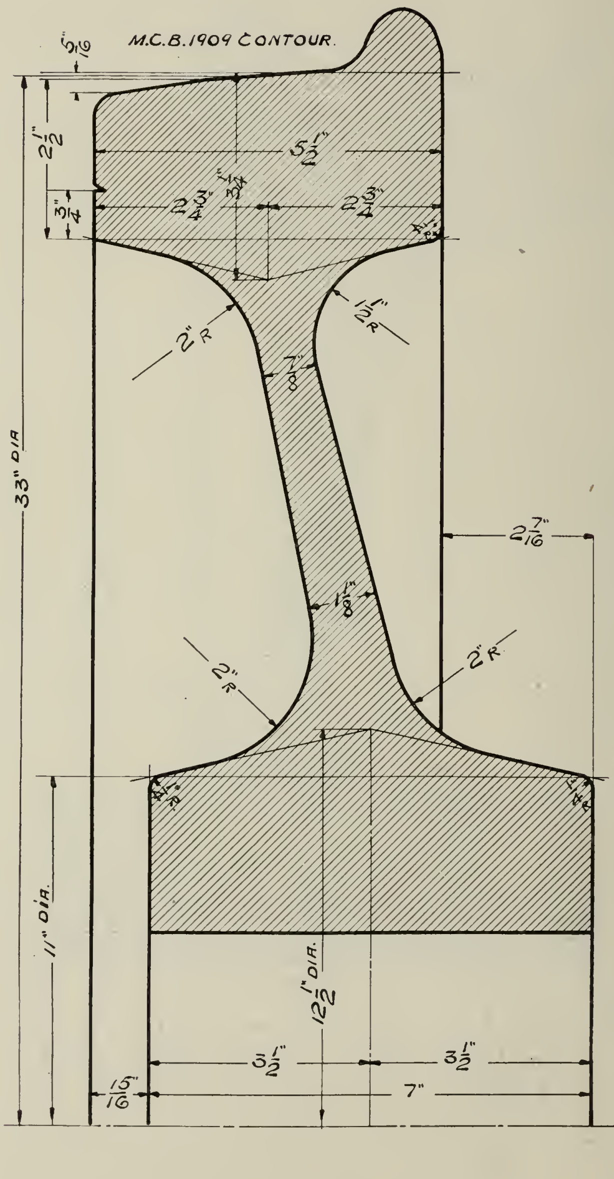

M.C.B. 1909 CONTOUR.
33" DIA
11" DIA.
12½" DIA.
5½"
2½"
2¾"
2¾"
¾"
$\frac{5}{16}$"
2" R
1½" R
2" R
2" R
⅞"
1⅛"
2$\frac{7}{16}$"
3½"
3½"
7"
$\frac{15}{16}$"

Fig. No. 14

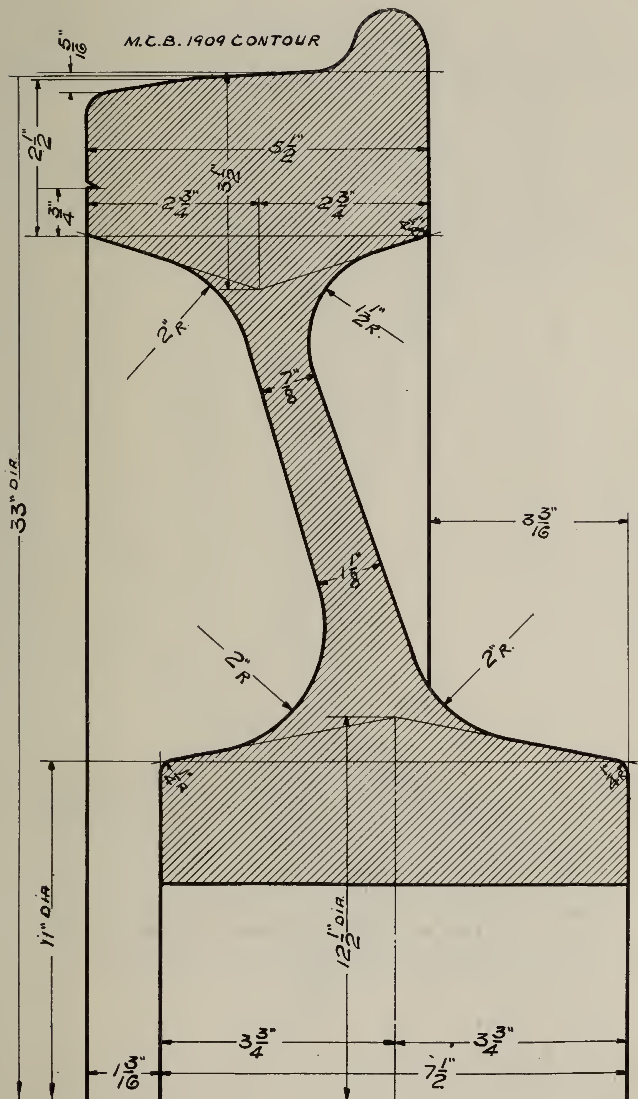


Fig. No. 15

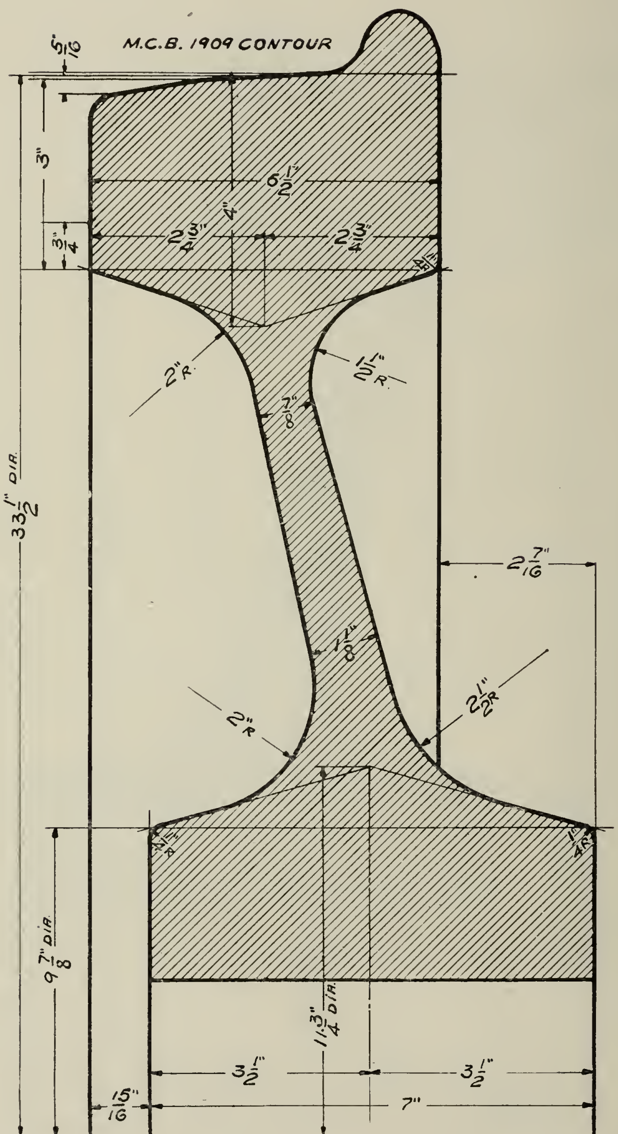


Fig. No. 16

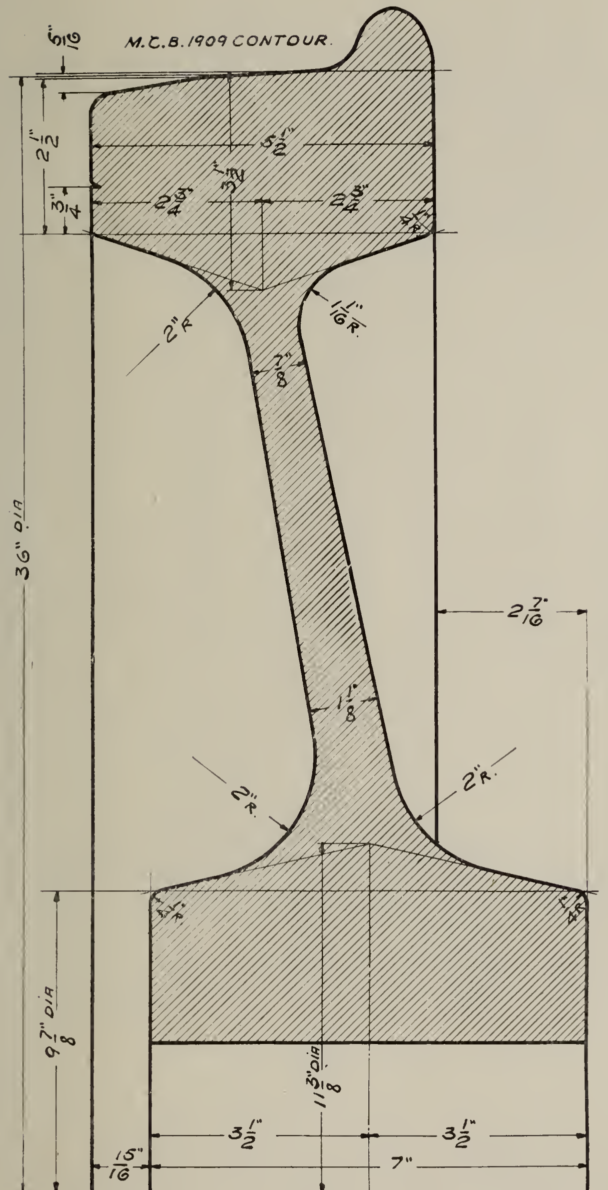
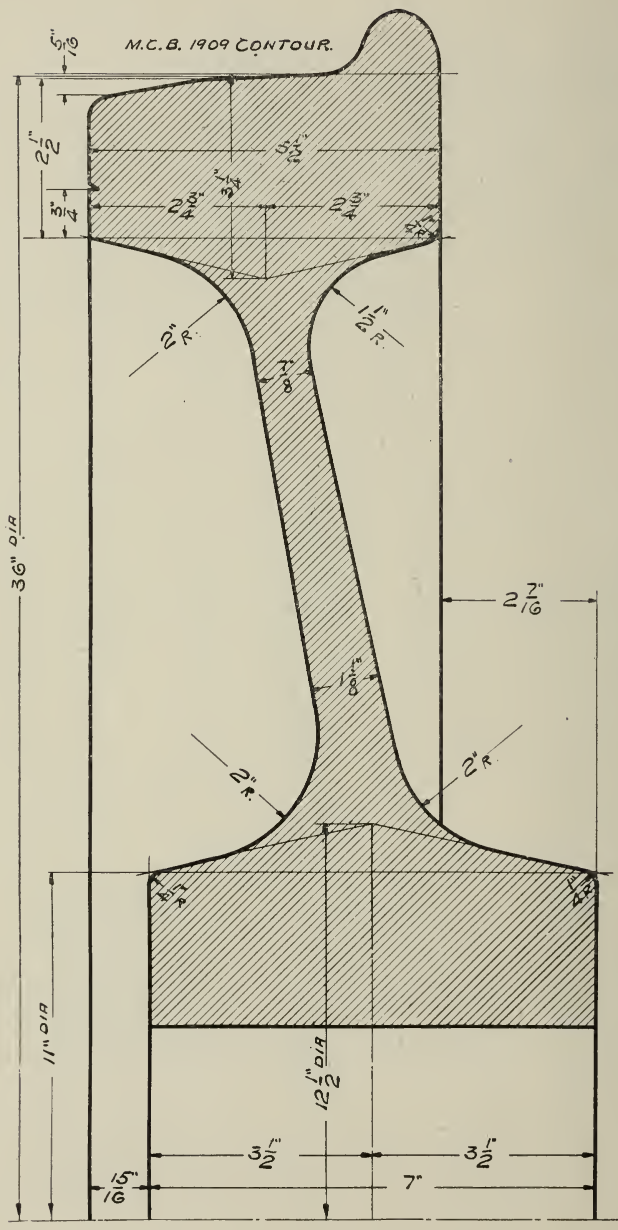

M.C.B. 1909 CONTOUR.
36" DIA
9 7/8" DIA
11 3/8" DIA
5 1/2"
2 1/2"
3/4"
2"R
2"R.
7/8"
1 1/8"
2 7/16
3 1/2"
3 1/2"
7"
15/16"

Fig. No. 17



M.C.B. 1909 CONTOUR.
5"/16
2 1/2"
3"/4
36" DIA
11" DIA
12 1/2" DIA
2" R.
7/8"
2 7/16"
3 1/2"
3 1/2"
15"/16
7"

Fig. No. 18

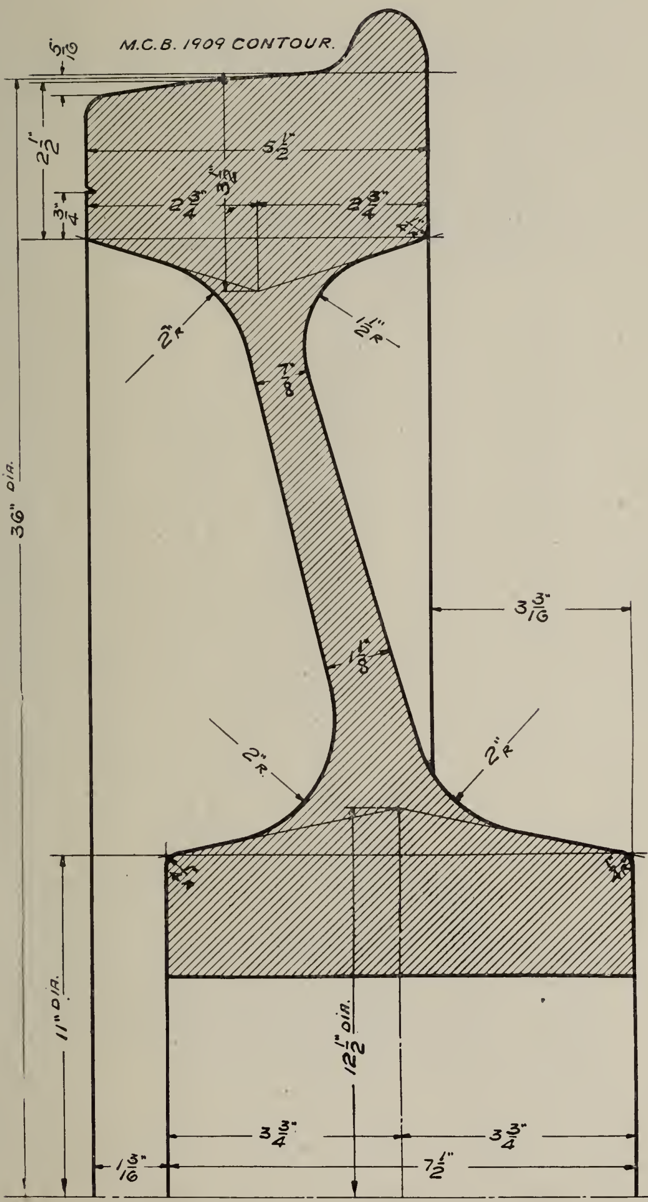

M.C.B. 1909 CONTOUR.
5/16"
2 1/2"
3/4"
5 1/2"
3 1/2"
2 3/4"
2 3/4"
2"R
1 1/2"R
7/8"
36" DIA.
3 3/16"
1 1/8"
2"R
2"R
11" DIA.
12 1/2" DIA.
3 3/4"
3 3/4"
1 3/16"
7 1/2"

Fig. No. 19

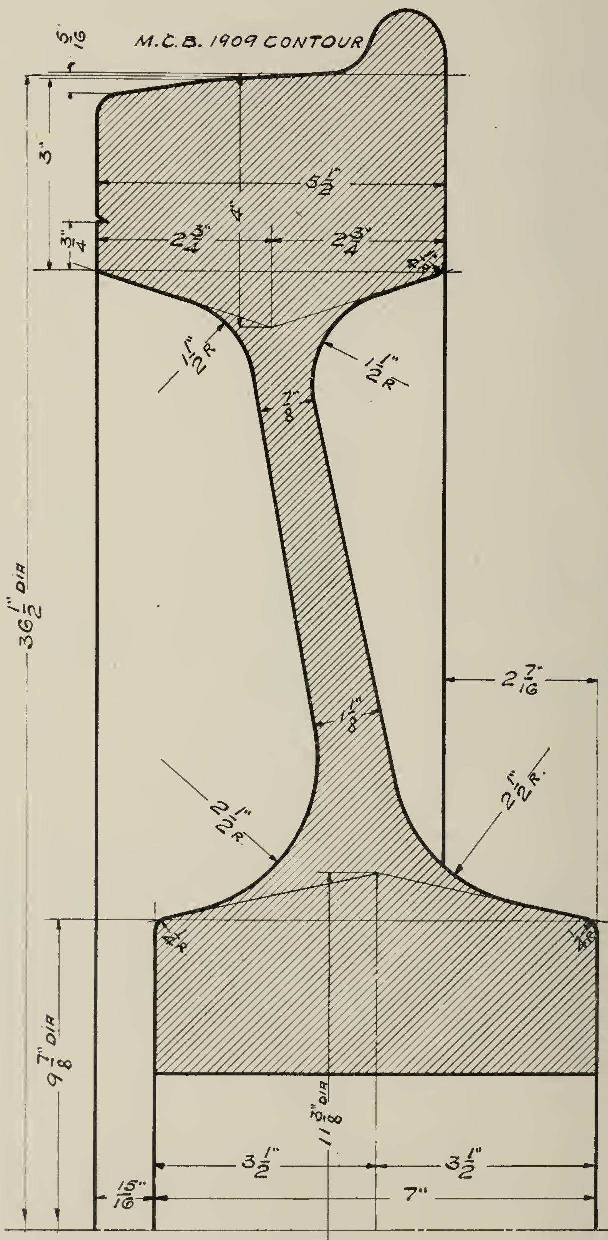

M.C.B. 1909 CONTOUR
5/16
3"
5 1/2"
4"
3/4"
2 3/4"
2 3/4"
1/4 R
1 1/2 R
1 1/2 R
7/8"
36 1/2" DIA
2 7/16"
1 1/8"
2 1/2" R.
2 1/2 R.
1/4 R
1/4 R
9 7/8" DIA
11 3/8" DIA
3 1/2"
3 1/2"
15/16"
7"

Fig. No. 20

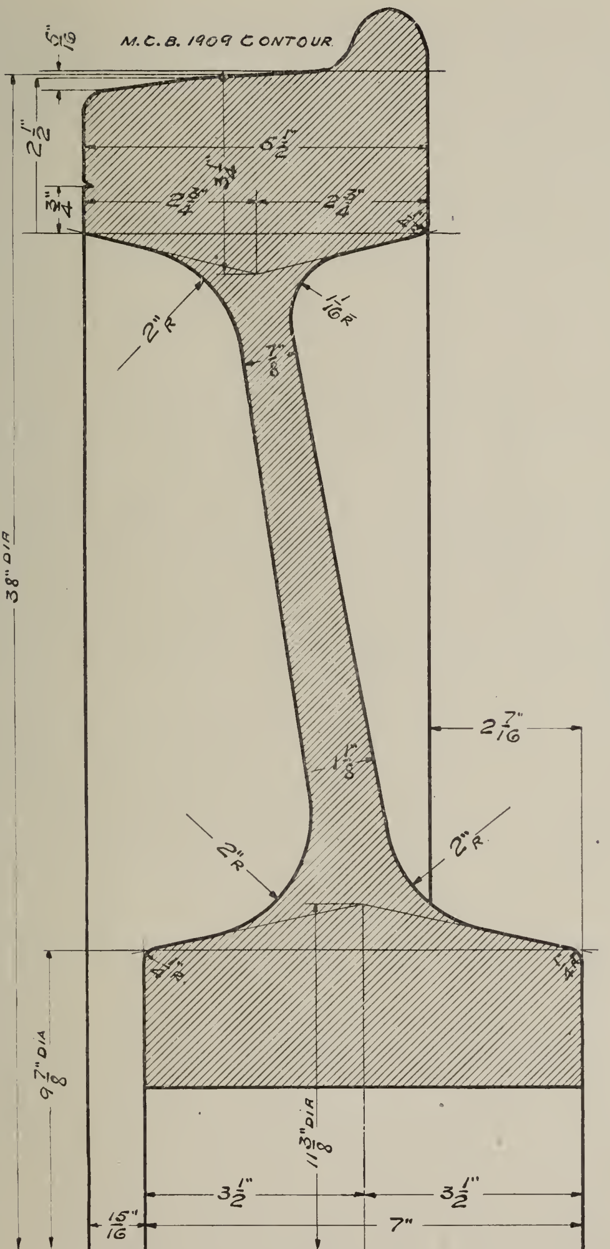

M.C.B. 1909 CONTOUR
5/16"
2 1/2"
3/4"
38" DIA
2"R
1 1/16 R
7/8"
1 1/8"
2 7/16"
2"R
2"R
9 7/8" DIA
11 3/8" DIA
3 1/2"
3 1/2"
15/16"
7"

Fig. No. 21

Mr. W. B. Hall (Mather Stock Car Co.): We have with us Mr. Davis and Mr. Radford of the Standard Steel Works of Philadelphia. I do not believe these gentlemen are enrolled members of the Club. I therefore make the motion that they have the privilege of the floor. (Seconded.)

The Chairman: That will be considered the sense of the meeting, if there is no objection. In this connection, the very valuable paper of Mr. Bacon is before the Club for general discussion, and I hope that this will be free and that I will not have to call upon you individually to discuss it. Ask any questions that you may have in your mind, so that we will get the full benefit of Mr. Bacon's experience while he is with us. We will be glad to hear from any one, and especially Mr. Radford of the Standard Steel Works or Mr. Davis, of the Davis Wheel, I presume.

Mr. Robert Radford (Standard Steel Works): Mr. Chairman and Gentlemen,—I am glad that it has been my privilege to be present here this evening to hear the paper upon the subject of wheels. I can readily conceive why the subject should evoke such general interest, because I know of nothing that goes round and round the circle so much, and it is vitally important that the railroads should secure the best possible wheels without regard to price, as the safety of the third party to the contract, that is, the traveling public, must receive first consideration. The opinion of the traveling public, supported and endorsed by the newspaper fraternity, should not be ignored.

I would impress upon you that I am not here as a competitor of the forged wheel, as we, and by "we" I mean all the manufacturers of the rolled steel wheel, feel that the latter is as much superior to the wheel which is pressed only, as we readily admit that the pressed wheel is superior to the cast iron wheel. (Laughter.) However, as Mr. Bacon has made the subject of his paper standard sizes, I will likewise speak to that end. I am sorry that the matter of standards should have been brought before this Association at this time, for the reason, as Mr. Bacon has stated, that the Master Car Builders' Association is giving the subject their attention, and the wheel committees will unquestionably report to their Association at the June convention.

There is to be another meeting of the committee and manufacturers' representatives next week. I firmly believe that the two bodies will reach an agreement that will be beneficial to the consumer and manufacturer. It would seem, therefore, that it would have been better had the matter of bringing it before this Club been delayed until after the convention. However, time will determine this point.

The meeting of the wheel committee to which Mr. Bacon refers was held December 8, 1911, and was primarily called for the adoption of a standard fastening and standard diameters of built up wheels in accordance with a suggestion made by Mr. Fuller

at the meeting of the Master Car Builders' Association on June 20, 1911, at Atlantic City.

Mr. Garstang, who is chairman of the wheel committee, suggested that it also cover solid steel wheels. The president of the Association referred both suggestions to the executive committee. It was my pleasure to be present at the meeting mentioned, and I am glad of this opportunity to say that the committee offered the manufacturers' representatives every courtesy and every opportunity to present their views. As Mr. Bacon has stated, much can be accomplished by co-operation between the buyer and seller. We are apt at times to overlook the fact that the organization of the buyer and the organization of the seller are both an aggregation of human beings with the same object in view, namely,—the success of their respective organization. It would, therefore, seem that more would be accomplished by active co-operation between these two forces than is accomplished by deceit of either toward the other.

It has always been our policy to be frank with our customers and lay before them truthfully our reasons for our actions. I believe that when this is done, much of the burden is removed from the buyer. While in a car in another city the other day, I was attracted by an advertisement which read,—"Don't rent or buy a house unless it is wired for electricity, all modern houses are. The use of electricity makes housekeeping a pleasure instead of a drudgery,—it solves the servant problem." In my opinion this was not judicious advertising, as it was not entirely truthful. It seems to me that it would have carried much more weight and proved of greater ultimate benefit if they had stopped with the statement, "Don't rent or buy a house unless it is wired for electricity, all modern houses are." You can imagine the disappointment of any consumer who would be foolish enough to accept the balance of the statement in good faith. It is true that electricity is very convenient, but it does not remove the drudgery, nor does it solve the servant problem, as from my own observation I find that the more electricity is used the more servants we need. Our statements should be concise and to the point, leaving nothing for assumption for those to whom such statements are made. I am reminded of the man who stopped his friend on the street and said to him, "Lend me $10, for a week, old man," to which the friend replied, "Certainly, where is the weak old man?" Both were entirely correct, but you can see what a chance had been made for an argument. I make these remarks particularly, because what I say to you now will show exactly why there were certain standards adopted for rolled steel wheels. Being the pioneers in the manufacturing of solid steel wheels, perhaps it will not be amiss for me to give a little of the history. The first solid steel wheels we made were cast and forged only. They were

not entirely satisfactory, and in 1904 we produced the first rolled steel wheel, withdrawing from service the wheels which have been forged only and substituting therefor the rolled wheels, as the results of our experiments and the results of services demonstrated that the forged and rolled wheel was the better product. As we had nothing else for comparison, we adopted the sizes and dimensions of the steel tired wheel. The diameters of steel tired wheels, were, as a rule, 28″, 30″, 33″, 36″ and 38″, with a 2½″ thick tire. It was natural, therefore, to make the rolled steel wheels of the same sizes and same thickness of rim, and it was for no other reason; consequently there would be no need of any other sizes. Railroads, however, were interested in using thicker tires, and in order that they might do this and fit the tires on the same center, it will be clearly apparent that it was necessary that the additional thickness be placed on the outside of the tire, increasing the diameter of the wheel by twice the additional thickness of the tire; in other words, the 33-inch wheel, fitted with a 2½″ tire became a 34″ wheel when fitted with a 3″ tire. Therefore, when we put the thicker rim on the rolled steel wheels, we naturally placed the additional thickness on the outside, so that the wheel should be interchangeable throughout with the steel tired wheel, and I think it is not necessary for me to say to you that this should be maintained, and I am of the opinion that from remarks made at the meeting at the wheel committee previously mentioned, the members of that committee were of this opinion.

Regarding the dimension of inside hub of engine truck wheels, we have adopted as a standard 12½″, which thus far has given ample bearing surface for the box, and I am sure if the dimension was adopted by all the manufacturers, there would be rare cases where the railroad company would insist on having it different. You must bear in mind the manufacturer is responsible in the majority of cases for the odd shapes and fastenings, because in our anxiety to get an order, we will do almost anything, and when you remove our willingness and the manufacturer will adopt a standard and refuse to make anything else, I do not think you will find the railroad will hesitate very long about adopting that also. If it should be found at any future time on particularly large engines that the box necessitated larger dimension of hub, it would be an easy matter to shrink a ring on the hub, thereby giving the diameter required. There is nothing objectionable to the ring, as the increased diameter is for a bearing only and does in no way pertain to strength.

As regards the wheel with 7½″ length and 11½″ diameter hub in order to accommodate the new axle with 6″ by 11″ journals, we must recognize the necessity of these sizes, as unquestionably this size axle has come to stay. At the time the 7″ length and 10″ diameter hub was made, engineers were of the opinion that no

larger axle would be made. It, therefore, becomes a question of whether it would be advisable for the railroads to adopt the larger size for all wheels and the manufacturers maintain one set of dies, or to have the two sizes and the manufacturers two sets of dies. There can be no argument that one and a quarter inch wall is ample as far as strength is concerned, and the wheels remaining tight upon the axles if properly mounted.

Regarding the thickness of the rim, I am sorry that I cannot agree with Mr. Bacon that in the rolled steel wheel the 3″ thick rim is not as efficient and economical as regards the service obtained as the 2½″. I readily admit that the rim can be made too thick and that three inches should be the maximum in order that the steel may be thoroughly worked. This is the advantage of the rolling process. If the three inch rim is thoroughly worked and homogeneous throughout, I cannot follow Mr. Bacon's remarks that you do not get the one half inch additional wear from the 3″ thick rim, as the limit of wear groove is the same distance from the inside diameter of the rim on either thickness. Of course, if the additional one half inch thickness of the wheel is added to the inside diameter, I can appreciate the 3″ thick rim will not wear as favorably per sixteenth inch of diameter, as the smaller the diameter the more rapid the wear, but if, on the other hand, as I have stated previously regarding the steel tired wheels, the additional one half inch is added to the outside diameter, the mileage per sixteenth inch of wear should show as favorably on the 3″ as the 2½″.

As regards shelling, I admit that the word is a misnomer as far as steel wheels are concerned, but nevertheless it has been adopted as a general term and we must accept it as showing the certain breaking down of the steel tired or solid steel wheels as well as the cast iron wheel. It is folly to say that the 2½″ thick rims will not shell equally as much as the 3″ rim. Some of the members here tonight may remember several years ago our engineer read a paper before this Club on the subject of shelling, in which we demonstrated that shells were a condition of service and that a wheel was apt to shell at any thickness, and as stated, concerning wear, the smaller the diameter, the more liability to shell. I think the real reason that we would like to see you adopt the one thickness of rim, say 2½″, is to avoid a multitude of dies.

Regarding machine work upon the wheels, I want to say to you that if wheels can be rolled to a diameter that will mate to the same exact size, then there is no necessity of machining. If the wheel is homogeneous throughout, why should there be any necessity? If it is not homogeneous, why use it at all? I have yet to find any reason for machining wheels other than to mate them and insure rotundity.

In a few words, I think the manufacturers are desirous of the

assistance of the railroad companies to secure as few sizes of wheels as will be necessary to operate. The fewer sizes the manufacturers have to make, the lower the cost. The minimum cost that will result to all manufacturers in the fabrication of a few instead of a multitude of sizes will, without argument, reflect to the advantage of the purchaser. You will appreciate that when ordered in large quantities and where orders of several railroads can be combined for the continuous rolling of one size wheel, we are able to save much labor and cost which would not be possible if we were compelled to change dies and rolls for each order from each railroad. I thank you.

Mr. Davis: I would like the privilege later on of being heard on this subject. This evening we merely came as listeners. I thank you.

Mr. Wilson (Railway List Co.): In reading Mr. Bacon's paper this afternoon, I was particularly interested in his rim specifications. I am sure many of us would be pleased to hear still further from him on that phase of his subject.

With reference to his recommendations for a two and one half inch rim thickness, I cannot believe that all in this room are satisfied with his explanation and reasons for such a limitation. His statement to the effect that the addition of half an inch of rim thickness makes all the difference between a good and poor wheel, deserves a more complete diagnosis.

I am not in a position to say that the three or three and a half inch wheel is a better wheel. It would be presumption for me to do so, but I do think that few motive power and car men would be willing to accept the loss in wheel mileage which goes with the thinner rim, until a better reason for so doing is forthcoming than that given by Mr. Bacon here tonight.

As a manufacturer's representative, Mr. Bacon's statement that a railway cannot know what it is getting in a steel wheel with a three inch rim owing entirely to the extra half inch of thickness, must carry weight. But if we are to accept it, are we not going to be dubious about the two and one-half inches as well. It would seem that if this were the case, one cannot know what he is getting in the metal of the hub, which is of considerably greater thickness. Of course I know that the demands of service on the rim and on the hub are quite different.

The railways want to get as much mileage out of the solid steel wheel or out of any other wheel, as it is possible to obtain, and it would seem that a more satisfactory answer to this question is to be demanded. An inch and a half of material for wear and machining is not as good a proposition as is two inches usable in the same way.

Mr. Bacon says experience recommends the two and one half inch rim. We all know what happens to the man who sticks to rule of thumb without seeking the derivation of the formula.

The Chairman: I understand Mr. Johnstone, of the Midvale Steel Works, is present. We would like to hear from him.

Mr. Johnstone (Midvale Steel Co.): Mr. Bacon has said a great deal about the adoption of standards which all steel wheel makers will hail with joy, as there are entirely too many sizes and modifications in wheels which cost the manufacturer a great deal and we would gladly enter in, with railroads or any one else, the creating of common standards and we hope that the committee will go at this matter in a decisive manner.

This subject of rim thickness is a subject in which we, as manufacturers of rolled wheels, do not agree with Mr. Bacon. There is no reason in our process of manufacture why a three inch rim should not have as homogeneous metal, be as compact, and give as much wear per sixteenth of an inch as a 2½″ rim. There may be difference in manufacture, but we make a wheel with a 3″ rim, or 2½″ rim and can see no difference in the material. Why rims over 2½″ are used as a tire and should not be used in a rolled wheel, I do not know. I cannot understand the reason for the statement that there is a difference in the efficiency of metal between a 3″ rim and a 2½″ rim, as the metal is all worked in uniformly and under the same pressure.

In the matter of the shelly spots, that is an old sore spot that has been debated for about twenty years. It has been taken up by the manufacturers, the railroads, committees of manufacturers and committees of the railroads and they have taken off tires, cut them up and analyzed the metal and gone into the different causes with absolutely no final result, excepting nobody knew exactly what conditions create shelly spots, other than conditions of service and operation.

I have in my pocket at the present time something that I am not going to read to you, because it is too long, but it is an article in a September magazine, called "The Railway and Locomotive Engineer," of a railroad man's experience giving thirty-one reasons that caused tires to shell from the operating standpoint. It starts with defective wheels and trucks and defective car trucks, defective engine trucks, improper manipulation, etc. In regard to the shelly spot proposition, we do not believe that there will ever be a metal produced that will not shell under certain conditions because every metal that has been produced so far has not been free from shelling.

Shelling is dependent somewhat on the condition of the climate affecting service conditions. I had occasion at one time to go into the matter of shelly spots on the Canadian Pacific Railroad. This refers to steel tires, but there is nothing that refers to steel tires that will not refer to the rolled steel wheel, because they are made in the same manner and of the same material as our wheels, therefore this is applicable to the rolled steel wheel. Speaking of the

Canadian Pacific, they had tires representing all foreign manufacturers and all American manufacturers, and upon investigation it was found that all the shelling was done in the winter. When the summer time came, there was practically no shelling of the material, showing that the condition of the frozen roadbed, the sliding of the wheels from the ice and snow, and different conditions like that were the things that contributed to the shelling. We have tried to eliminate, in fact, all the tire manufacturers have been very desirous of eliminating the shelling out of tires. It has been a subject which has been studied by their engineers for a long period of years with but few practical results. Tires have been made that were heat-treated, which is the highest type of metal that we know of today, thoroughly heat-treated and put into service, and when they were put into service, it did not eliminate the shelling, although the material was superior to any that had ever been tried in that line. With the added loads on rolled steel wheels and higher braking power you never will get away entirely from shelling. It is not a question of the metal; it is a question of higher braking power, added weights and the service and operating conditions that will cause any metal to shell at times.

There is another matter here,—that of machine work, we make use of it only to true up the contour of the wheel. A great many of the railroad people—I would say a majority of railroad mechanical men, are under the impression that the exterior skin, you might call it, of a tire or rolled wheel is worth very much more than a similar amount of metal underneath. There is a chill thrown into the rolled surface of the metal, by the rolling, and it has been our experience that the mileage per sixteenth inch wear for the first quarter of half inch exceeded any mileage attained afterwards from the tire, and we see no occasion for machining, unless your process of manufacture makes it absolutely necessary. There is nothing the matter with our metal that makes this machining necessary, the only reason that we machine it at all is to true up the contour. In fact, we turn out about 75 per cent of our wheels and our tires absolutely in the round and we have found more satisfactory service and larger mileage than from those that have been machined.

The Chairman: Mr. Canfield, with your experience in wheels, you ought to be able to discuss this subject.

Mr. L. T. Canfield (Union Draft Gear Co.): I do not believe I am qualified to speak upon the subject. I have not had any great amount of experience with the steel wheel, although I did investigate troubles with cast wheels for a while, but ran out of trouble and I ran out of a job. (Laughter.)

The Chairman: Mr. Bunnell, of the Rock Island.

Mr. F. O. Bunnell (C. R. I. & P. R. R.): I do not think

that I have had sufficient experience with the rolled steel wheel to be able to add anything to what has been said.

Mr. Johnstone: If you will pardon me, I wish to say that I was talking of a rolled steel wheel and not of a pressed wheel. There may be something in Mr. Bacon's process of manufacture which would make a 3″ rim impossible, and what I said applies to a wheel that has been rolled.

The Chairman: I am sure there is some one in the room that can tell of their troubles out in the yard, even if they cannot discuss this technically. I should like to hear from some of those fellows who will tell about these troubles when the cars and engines come in with wheels in this condition which they say does not exist. Mr. LaRue, cannot you? You can, if you will. Prof. Endsley, have you anything? Mr. Little, of the Northwestern? Prof. Smith?

Mr. C. E. Miller (Safety Car Heating & Lighting Company): "Mr. Chairman, I unfortunately come under the heading of those who have but a limited experience with the rolled wheel, but I want to say in regard to the 2½ and 3 inch rim that what little experience I have had would indicate that the superiority of one over the other is entirely a question of material and manufacture.

A particular case I have in mind was one batch of about two hundred wheels of one manufacture with 2½″ rims which were placed under seven thousand-gallon tenders. These wheels shelled out very badly, and this shelling was attributed by the manufacturers solely to the braking conditions on the tenders. The tenders were behind engines equipped with Westinghouse A 1 and E. T. brakes, none of which had high speed brakes. The braking power on the tender was based on the old method of 90 per cent of the light weight of tender at 60 pounds equalization. There were wheels of another manufacture with 3″ rims in service under the same class of tenders in which no shelling was experienced, so in that particular case it was pretty good evidence to the particular railroad I have in mind that the shelling out of the wheels with the 2½″ rims was not due to service conditions, but rather to manufacturer's defects.

I do not relate this occurrence from the view point of a wheel expert, but only to emphasize the fact that the quality of material and workmanship are the paramount features of rolled steel wheel manufacture, and that these two items should be considered first, and detail design should be determined later, in accordance with data secured from extensive experience.

The Chairman: Is there any one else in the room that has anything in mind, or questions to ask in connection with this?

The Secretary: Mr. Chairman, Mr. Forsyth, whom I see in the room, has a bad cold, has asked me to read the following for him.

Mr. William Forsyth (Railway Age Gazette): Perhaps the most interesting and important feature of the forged steel wheel when used in freight car service is the cost of the total mileage obtained from it. It is claimed that on account low, first cost and long life the expense per 1,000 miles will be less than for chilled iron wheels, and at the price of $14 for a 33″ forged steel car wheel, this claim may be easily sustained with the additional advantage of greater safety. The service will depend upon the quality of the steel, which in forged wheels is similar to that on locomotive driving tires, and the latter require frequent turning on account of sharp flanges, flat spots and worn tread. The forged wheel will require the same treatment, and its total mileage will depend on its resistance to the wear which produces these defects and to the available thickness for repeated turning.

In this paper Mr. Bacon takes a decided stand in favor of a rim 2½″ thick instead of 3″. The M. B. C. limit of one inch thickness of rim allows a body of steel for wear of 1½″ in the former and of 2″ in the thicker rim. Under present conditions of manufacture the wearing quality of the steel is obtained by the work done in rolling or forging, and it is claimed that the depth of penetration of this work is best secured in the 2½″ rim. Beyond that the steel is softer and more liable to the defects which correspond with shelling out in the chilled iron wheel. The limitation placed on the thickness of the rim is, therefore, due to the quality of the steel found beyond the 1½″ wearing limit, and if this steel was equally good at 2″ depth, the objection to a 3″ rim would not be sustained, and an additional mileage would be obtained from the thicker rim and the cost per 1,000 miles reduced.

A similar condition existed fifteen or twenty years ago when light and weak tire mills were making 4″ tires, and they were found defective beyond a certain depth, while the 3″ tires gave a more uniform and satisfactory service. Since that time heavier and stronger tiremills are used, and the 4″ tire is in general use for freight service, which would indicate that the degree of penetration in making a tire or a steel wheel depends on the strength of the machinery employed in manufacture.

The reasons for favoring the thinner rims are, therefore, based on limitations in the present process of manufacture, and in advancing such reasons there is a virtual admission on the part of the forged wheel maker that he cannot produce a wheel which has sound steel in the tread beyond 1½″ thickness. It may be best to retain the 2½″ rim for the present, but it seems inevitable that if solid steel wheels are to come into general use in freight service, economic conditions will require a greater depth of steel for the wearing body, and this demand will result in such improvements in the process of manufacture as will provide a grade of steel suitable for the service throughout a deeper rim. It is reasonable to expect this, because steel forgings of a uniform grade

of steel of much greater thickness are made for machinery, and for guns, shafts, etc., and it should not be difficult to apply the same processes to the manufacture of steel wheels.

The details of the modern manufacture of steel wheels are not described in Mr. Bacon's paper, but the low price at which they are sold—at the rate of a little over two cents per pound—would not indicate that any special treatment is given beyond forming accurately to shape under sufficient pressure to secure solid steel structure to a limited depth. The improvement in hardness, toughness and fineness of grain, which is obtained by heat treatment and oil tempering, has apparently not been applied to the forged steel wheel, and it is probable that further experience may show that the additional expense involved in these operations will be well justified by the longer life and greater mileage which should be thereby obtained.

THE CHAIRMAN: Is there any one else who cares to say anything on the paper of the evening, before we ask the writer to close? If not, I would like to ask Mr. Bacon, if he recommends the 9⅞″ hub, both for high speed passenger and freight service or if he would make any distinction in passenger wheels as regards the hub. I will ask Mr. Bacon to close the paper.

MR. BACON: I heard a story about a month ago that about expresses my feelings at the present moment. There was a couple who were staying at a city hotel and they had with them their ten-year-old son, who was very restive in the hotel room, being a boy who was accustomed to play around the lots at home, so he wandered out of the room and was playing in the hallway and while playing in the hallway he commenced fooling with the standpipe of the hose that was to be used in case of fire, and the first thing he knew, the hose was swishing around the hall like a snake, and the water was squirting around, wetting up everything in general, and the boy was getting a good wetting himself. The father came running out into the hallway and called out, "Willie, Willie, what have you done?" The boy, in a very excited tone said: "I ain't done nothing, but I sure have started something."

Now, there is one thing I want to say, and say most positively,—nothing that I have said tonight must be considered in any possible way from the standpoint of an advertisement for my company. I might go a step further and in truth say that I was for more years engaged in the manufacture and sale of rolled steel wheels than I have been months in forged steel wheels. I will go further and in truth say that the observations which I have made in my paper, particularly as regards rim thickness, are based on records of rolled steel wheels. I am not advocating the use of a forged steel wheel against a rolled steel wheel, or vice versa. But I want it distinctly understood that I am not abusing the privileges of the Club by seeking to advertise any particular brand of

goods. The statements I have made have been my observations as an engineer,—what I have said I will stand by,—and I only ask investigation of the matter on your own individual roads.

In answer to Mr. Goodnow's question I would say that I consider 1¼″ minimum hub wall thickness is all that is required, even in high-speed passenger service, in connection with properly-made solid steel wheels, when mounted on axles up to and including 7″ diameter wheel-seats,—while over 7″ I would consider hub wall thickness should be over 1⅜″ minimum. And I would not discriminate as between high-speed passenger and heavy freight services.

I hate to get into a dispute with Mr. Radford. He knows this business backwards and forwards and sideways, and he has had experience in this regard beyond that of most men in the business. But I must call attention to the fact that two or three times when he was speaking on this question of rim thickness he said he did not see why 3″ rim thickness would not be just as good as 2½″ "if it was as homogeneous." That is what I say, "if it is just as homogeneous," but you have got to show me, and though I have examined a great many wheels of different manufactures, I have failed yet to see that they were as homogeneous in a 3″ rim as in a 2½″.

Mr. Johnstone, you spoke tonight about the ability to make homogeneous tires 3½ inches thick, perhaps 4″ thick. I will not dispute you. You are an old tire man, and I suppose you know what you are talking about. If you say it is possible, I will assume that it is possible. But can you compare the manufacture of a tire, that you can get at from four sides, to the manufacture of a steel wheel, where you can get at it from only say 3¾ sides?

I am afraid if I say any more I will give away all the secrets of the business.

Gentlemen, I do not want to take up any more time, but I want to repeat what I said in my paper. There is no man in this country today who has worked harder to introduce wheels without machining on the tread than I have. There is no man who has given more thought to it. I have believed in it, and I believe in it today within certain limitations, but when I saw, not long ago, the records of several hundred wheels made by the same people at the same time and used in the same service, and with the engineers of the railroad I went over those records and eliminated every possible variable, so that the records of four hundred wheels which had not been machined, and four hundred wheels which had been machined, were comparable, and I found that the mileage of the unmachined wheels was no greater than the mileage of the machined wheels,—when I found that their process of manufacture in simply leaving the tread of the wheel as rolled had rolled in all the impurities that might be lying around loose, and had caused some flaking of the metal,—that was the straw that

broke the camel's back. I had been looking for it for some time,—I had felt that leaving the wheel as rolled was rather risky,—and dubious as to the advisability of having mere dimension as the sole controlling factor. I have been looking for that sort of trouble, I have been fearing it, and it is coming to my notice recently that it is showing up.

There is only one thing more. Mr. Radford put me on the defensive by one remark that he made. He rather claimed that I was premature in bringing before this Club the question of Standard Designs while it was being handled by the M. C. B. committee. I am not officially sanctioned by the M. C. B. committee to speak for them, or to represent them, but I can say this: That if I had felt I was warranted in taking up any more of your time, I should have brought out in my paper several other things which the M. C. B. wheel committee wish to bring before the railroad men of this country, and which it was suggested to me by some of the Committee that they would like very much to have me advertise in my paper tonight.

Gentlemen, I thank you very much for your attention.

On motion of Mr. W. E. Sharp, a vote of thanks of the Club was extended to Mr. Bacon for his very able paper.

Adjourned.

THE DAVID L. BARNES LIBRARY

SPECIAL NOTICE.

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was held at the Karpen Building, 900-910 South Michigan Boulevard, Tuesday Evening, March 19, 1912.

President C. B. Young in the chair. The meeting was called to order at 8:00 P. M.

Ahldin, David
Allison, W. L.
Bentley, H. T.
Borrowdale, J. M.
Bjurstrom, G. A.
Brown, C. L.
Brown, S. D.
Canfield, L. T.
Carroll, W. F.
Casgrain, G. D.
Chisholm, J. E.
Conradson, P. H.
Covert, M. F.
Curtis, T. H.
Davids, H. E.
Dix, G. E.
Doran, H. G.
Dunham, W. E.
Endsley, L. E.
Egolf, F. M.
Ensign, H. W.
Evans, W. H.
Friday, C. B.
Gears, R.
Geer, A. B.
Goodnow, T. H.
Guigrase, E. L.
Green, Herbert
Hall, W. B.
Harris, D. T.
Hibbard, E. R.
Hibbard, J. W.
Hooper, B. C.
Hooper, W. H.
Houchin, B. F.
Hyland, R. H.
Jenks, C. D.
Johnson, J. W.
Jones, E. L.
Kipp, A. R.
Kucher, T. N.
Lammedee, J. M.
LaMar, A.
Lawrence, W. J.
Lickey, T. G.
Lohman, H. F.
Lorenz, F. A. Jr.
Lovell, E. P.
Lundehn, Otto
Macpherson, A. F.
MacAlpine, A. R.
McMaster, C. L.
Midgley, S. W.
Miller, C. L.
Miller, J.
Milles, L.
Mitchell, W. A.
Moore, J. B.
Moore, J. E.
Morehead, L. B.
Morris, H.
Naylor, N. C.
Neely, B. J.
Olmsted, C. J.
Ormsby, Wm.
Osborn, C. H.
Park, S. T.
Parker, P.
Robb, J. M.
Rockwell, A. L.
Rosenthal, A. E.
Ross, M. A.
Rowley, S. T.
Royal, Geo.
Ryder, G. E.
Schragg, C. F.
Seley, C. A.
Sharp, W. E.
Scheffer, A. M.
Schmidt, E. C.
Simmons, Stephen
Sinkler, Jos.
Smith, M. R.
Smyth, C. B.
Sorenson, F. C.
Squire, W. C.
State, R. E.
Taylor, J. W.
Tinker, J. H.
Turner, G. S.
Van Sweringen, G. N.
Walsh, W. J.
Wilson, L. F.
Woodhull, M. J.
Young, C. B.
Young, C. D.

THE PRESIDENT: Please come to order, gentlemen. I hope every one will register before they go out. I think a good many of you have not so far.

The first order of business is the report of the Secretary.

THE SECRETARY: Mr. President, I have the following membership statement:

NEW MEMBERS.

Name	Occupation	Address	Proposed by
J. A. Rees,	V. P. Empire Iron & Steel Co.,	Chicago, Ill.	D. T. Harris
W. V. D. Wright,	S. A. Railway Steel-Spring Co.,	Chicago, Ill.	N. C. Naylor
F. L. Barber,	Standard Car Truck Co.,	Chicago, Ill.	L. W. Barber
B. A. Broom,	Mech. Insp., C. B. & Q. R. R.,	Lincoln, Neb.	J. G. Crawford
Wm. Ormsby,	Mach. Shop Foreman, Ill. Cen. R. R.,	Chicago, Ill.	Jos. Miller
F. M. Egolf,	Rep. Curtain Supply Co.,	Chicago, Ill.	S. W. Midgley

MEMBERSHIP STATEMENT.

Membership, February, 1912	1,634
New members approved by Board of Directors	6
Total membership	1,640

THE PRESIDENT: These names have been passed on by the Board of Directors and will be listed as members.

Dr. Conradson wishes me to announce that he will be glad to explain the full working of this apparatus between the hours of nine and four tomorrow if any of our railroad officers wish to send representatives over to see it. The Galena Oil Company has gone to considerable trouble to bring this apparatus here and erect it and I shall ask if there is any one present who desires to take advantage of their offer to demonstrate its workings tomorrow.

Mr. Taylor has just advised me that the exhibit of railway specialties on the floor above will be open to our members after adjournment and that we are invited to inspect same.

I now take pleasure in introducing to you Dr. P. H. Conradson, of the Galena Signal Oil Company, who will deliver the paper of the evening. Dr. Conradson (applause).

Address and Demonstrations on

LOCOMOTIVE VALVE AND CYLINDER LUBRICATION IN CONNECTION WITH SATURATED AND SUPERHEATED STEAM

BY DR. P. H. CONRADSON,

Chief Chemist Galena Signal Oil Co., Franklin, Pa.

DR. P. H. CONRADSON: Mr. Chairman, and Members of the Western Railway Club: A few days ago I received a letter from my friend Mr. Walsh, better known amongst you men as "Billy" Walsh, stating that the Western Railway Club would like to have

me come here and give a talk on "Locomotive Valve and Cylinder Lubrication in connection with Saturated and Superheated steam." I wrote him I would be glad to come provided they furnished a good-sized room, plenty of steam and water and gas and a good attendance, and I am glad to say that all these things have been fulfilled above my expectations, and I also want to congratulate the Club on having such nice quarters.

As you know our subject this evening is an interesting as well as an important one, and some lively and instructive discussions, probably will follow my address, I sincerely hope this will be the case, as much valuable information oftentimes is thereby brought out, I will therefore make my talk on "Locomotive Valve and Cylinder Lubrication in connection with Saturated and Superheated steam" as short and concise as I possibly can, doing justice to my subject.

After the conclusion of my talk and our discussions, I will conduct demonstrations with the two apparatus which I have constructed for the purpose of showing the behavior of valve and cylinder oils in steam at various temperatures from ordinary saturated or wet steam up to the highest degree of superheat, and to show how easily the comparative thick valve oils when properly compounded and suitable for the service conditions and requirements can be emulsified and atomized in the tallow pipe, and intermingled with the live steam as the same enters the steam chest or preferably above in the saddle casting steam passages or steam pipe.

As a few preliminary remarks it might be stated that the object of superheating the steam after it leaves the boiler and before it reaches the steam chest and cylinders, is principally intended for the purpose of drying the steam, removing the moisture suspended in the boiler steam, generally referred to as saturated (wet) steam. By raising the temperature above that proportionate to the pressure at which it is generated, suspended moisture becomes evaporated and the steam enters the steam chest and cylinders in a dry state, and at a higher temperature than that corresponding to the steam pressure in the steam boiler, and thereby preventing or minimizing the cylinder condensation. By its use therefore steam can be very efficiently utilized, increasing the locomotive capacity, reducing the fuel and water consumption, in ratio to the amount of work performed in comparison with saturated steam under similar conditions, and this without any additional strain on the boiler, flues and fire box.

While the valve and cylinder lubrication with saturated steam in locomotive practices have been during the last fifteen or twenty years pretty well discussed and threshed out by the various railroad clubs, technical papers and others, I will during my talk consider some features in comparison with superheated steam

lubrication that I hope will be of interest to you and have a tendency to improve the present practices generally used.

The problem of Locomotive Valve and Cylinder Lubrication in connection with Superheated Steam, while pretty well worked out and sound practices established in Europe in accordance with prevailing conditions there, is however comparatively new with us and in a more or less experimental and developing stage.

In 1907 there was a world's record of 2,000 locomotives equipped with superheaters, of this number only eight are credited to the United States:—since that time however, quite a number, probably 2,000 locomotives, have been equipped with superheaters in this country and Canada, and the practice seems to be spreading very fast all over the country, because the efficiency of superheated steam, in comparison with saturated steam, at least in simple engines, is now pretty well recognized, on account of the increased locomotive efficiency, economy in water and fuel consumption, etc.

The pioneers, the roads that have gone into the superheated steam question, in locomotive practice most energetically and on a large practical scale are, as you probably know, the Canadian Pacific and Great Northern and one or two more roads. To these said roads we are greatly indebted for the practical knowledge and experience gained as to the efficiency, economy and utility of superheated steam in comparison with saturated steam in locomotive service in accordance with existing conditions here, and from which the rest of us will derive much benefit, especially in connection with our subject under consideration.

There are two types of superheaters, the original or early type known as the "Smoke-Box" type and the so called "Fire-Tube" type. With the former a relative low degree of superheat from 50° Fah., to 100° Fah., is generally produced;—with the latter high degree of superheat from 150° Fah., to 300° Fah., or higher.

There seems to be some confusion in the term "degree of superheat," and before going further into the subject we may as well make ourselves clear on this point. We often hear they have or use very high superheat. It may be so or it may not, unless qualified with a given boiler pressure and steam chest temperature. One hears of 100, 150, 200, 250, and 300 degrees superheat, or 500, 550, 600, and 650 degrees temperature at the steam chest.

Let us for illustration take 300 degrees superheat at 160 pounds boiler pressure. This should mean 664 degrees Fah., temperature at the steam chest, and with the same degree of superheat with 210 pounds boiler pressure, 686 degrees Fah., temperature at the steam chest.

On the other hand, one hears of steam chest temperatures of 550 degrees Fah., or 650 degrees Fah., with a boiler pressure of say 175 pounds corresponding to a steam temperature of 371 de-

grees Fah., and with 550 degrees Fah. steam chest temperature we have 550 degrees—371 degrees=179 degrees Fah. of superheat. With a steam chest temperature of 650 degrees Fah. we would have, with a boiler pressure of 200 pounds per square inch, a superheat of 268 degrees Fah., and with a boiler pressure of 175 pounds 279 degrees Fah. of superheat.

From this you will appreciate that in speaking of degree of superheat it is well to state both boiler pressure and temperature corresponding to same, as well as the temperature of the steam as it leaves the superheat or enters the steam chest.

As is well known, saturated (wet) steam possesses a certain amount of lubricating qualities, this owing to the presence of suspended water vapor, or moisture, it might be likened with fog; i. e., minute microscopic globules of water vapor interspersed with the gaseous steam. Superheated steam, at least at high degree of superheat making the steam absolutely dry, free from suspended water vapors, takes the physical properties of or follows the laws of perfect gases very nearly; see "Properties of Steam," by Peabody, and others.

In this superheated or dry state the steam apparently has no inherent lubricating qualities whatsoever, that is, as long as it is in a perfectly dry state or condition. As soon, however, as the temperature and pressure is reduced sufficiently so as to throw out in suspension water vapor or moisture, the steam becoming wet or saturated, it resumes its lubricating properties.

In locomotive superheat practice as advocated at least abroad, a high degree of superheat is aimed at, that is, a sufficient excess of superheat, so as to prevent condensation in the cylinders, that is, dry, superheated steam goes out in the exhaust. Such practice requires close attention to the problem of valve and cylinder lubrication, which besides a proper oil also very materially and essentially includes proper design of valves and cylinders, bushings and piston rings, as well as the metal used in these parts. I will take this matter up as I go along in a little further detail.

In the early practice in this country in connection with superheated steam, trouble from cracked or broken cylinders and other steam parts were often encountered and the trouble oftentimes laid to the valve and cylinder oil. However, by modifying the design and using better or higher grade of metal, these difficulties have almost disappeared, at least on railroads which have had a great deal of experience.

As an illustration of the importance of a suitable material in the piston rings, besides proper design, in connection with high superheated steam, I may state that on a certain railroad in the Northwest, now having several hundred locomotives equipped with superheaters using rather high degree of superheat (200 to 250 degrees F.) When they first started in with superheaters they were using ordinary gray iron metal in their steam chest and

cylinder piston rings similar to that they were using in their saturated steam engines, and they had a great deal of trouble from these rings wearing out. This road is now using a dense, fine grained, high-grade air-furnace iron, and are getting, so stated, from 18,000 to 30,000 miles per piston ring, while with the old ring metal they got less than 1,000 miles. In fact, with the new metal this road is now getting as good mileage out of the rings with their superheaters as they were with their saturated steam engines.

Another road with a large number of superheated steam locomotives has had about the same experience. Of course it should be borne in mind that the metal in the piston rings probably varies a great deal in the chemical composition as well as the physical structure of the different roads, therefore the above cannot be laid down as a general rule. Each road adopting superheaters will have to find out the best material to use according to their engine practice, degree of superheat and other conditions. However, from this you will realize the importance of suitable metal in your piston rings in connection with valve and cylinder lubrication of superheated steam locomotives. In the above cited cases the same oil was used with both the old ring material and the new. This is to emphasize the fact that when one considers valve and cylinder lubrication in general, both with saturated and superheated steam, one has to go further than the oil itself.

Some apprehension has in the past prevailed with railroad officials as well as with the locomotive engineers that valve oil would not stand a high degree of superheat, but would burn or carbonize in the steam chests.

This evening I propose to demonstrate to you that a properly compounded, high grade valve oil for superheated steam purposes, will neither burn nor carbonize in superheated steam, even as high superheat as 800 to 1,000 degrees Fah. On the other hand, it is possible to partly carbonize even the best of valve oils in what might be called unfair treatment or unsuitable or improper locomotive practice. Now, gentlemen, this is one of the objects we have in making this demonstration to you to-night, to show you that with properly compounded valve oil for superheated steam you can have any degree of superheat without carbonizing or burning the oil in an atmosphere of steam.

On the other hand, of course if you try to put the same degree of heat upon the oil, or get the same degree of heat in your steam chest and cylinders, and admit air or other gases and exclude the steam, you will certainly carbonize or burn your oil, even the best kind of oil, because it can be burned; it is not asbestos. Therefore later on I am going to show you, in connection with what I have just said, the importance of taking certain precautions to prevent the accumulation of carbonized or burned oil or foreign material in your steam chest and cylinders. As I

said, it is possible to carbonize even the best valve oil in what might be called unfair treatment or unsuitable or improper locomotive practice.

This statement leads me to say a few words in connection with some other factors that have an all-important bearing on the problem of successful valve and cylinder lubrication of superheated steam locomotives.

It has been found in practice that cracking the throttle so as to let into the cylinders a small amount of steam when the engine is drifting, and still better the use of so called drifting valves, i. e. a steam pipe leading from the dome through the cab to the cylinder:—when the throttle is shut off in drifting the drifting valve is opened, letting in a sufficient amount of steam into the cylinders, this prevents either cold air from being drawn in, thus avoiding sudden cooling of the cylinder walls;—or the drawing in of dust, ashes or cinders from the smoke stack gases;—or another device largely used in superheated steam practice, namely the so called by-pass. It consists of a steam passage which connects both cylinder ends, which passage is closed by a cylindrical cock in the middle. So long as the engine is running under steam the cock is kept closed. When the throttle is closed the engineer opens the by-pass valve. This practice prevents either cold air or smoke stack gases with their dust and dirt from being drawn in, thus greatly aiding the lubrication.

The following illustrations are to the point in connection with the drawing in of the smoke stack gases with their dirt, cinders and ashes into the cylinders when the engines are drifting, and what I would call unsuitable or unfair engine practice. I have had occasion to examine deposits accumulated on locomotive cylinders and piston heads from some railroads where the use of drifting valves have not been adopted in general practice. A few of these accumulations show as follows:

1.

13.35%	thick oil.
2.60%	oily, gummy matter.
57.15%	carbonaceous combustible matter (coal and coke matter).
26.90%	red ash, principally iron oxides, silicious matter.

After removing the oil and oily matter, the deposit was non-magnetic, indicating practical freedom from metallic iron.

2.

24.25%	thick oil.
0.90%	oily, gummy matter.
48.78%	iron metal wearings.
8.18%	iron oxides and silicious matter.
17.87%	carbonaceous combustible matter.

After extracting the oil and oily matter, the deposit was very strongly magnetic containing a large amount of metallic iron.

3.

6.45% oil and oily matter.
35.70% coky, carbonaceous combustible matter.
57.28% metallic iron, iron oxides and silicious matter.

Mineral matter strongly magnetic from metallic iron wearings.

4

4.2% oil and oily matter.
41.0% metal wearings, iron oxides, silicious matter.
54.0% coky, carbonaceous matter.

Mineral matter strongly magnetic.

The above clearly illustrates the advisability of preventing smoke-stack gases with their inherent dirt, dust, grit, etc., to be drawn into the cylinders while the engines are drifting. As seen from the analyses a comparatively small amount of oil binds together a large amount of mineral matter forming a sticky deposit which bakes on the metal much harder with superheated steam, especially high superheat, than would be the case with ordinary wet or saturated steam.

Now this means that most of this deposit does not come from the oil. When engineers open up their steam chests and cylinders and find deposits they think that it comes from carbonized oil. Now I do not agree with that, far from it, because if you remove all the carbonaceous matter that comes from the ashes and cinders, and the mineral matter such as iron oxides and silicious matter, you will find very little oily matter, and then we come back to the point of the importance of using a socalled drifting valve during the time the engine is drifting and the live steam is shut off, that is, when the engine is not running on steam. If you have an auxiliary pipe admitting a certain amount of steam into the steam chest and the cylinders, that will prevent the cool air from getting in and chilling the walls of your cylinders, it will prevent ashes and cinders being drawn in. I consider this one of the most important things in locomotive practice in connection with superheated steam as well as saturated steam.

I have found another interesting thing. In alkali or foamy water districts the superheaters aid the valve and cylinder lubrication. I had occasion recently to examine two locomotives equipped with superheaters that had been in continuous service over a year in an alkali water district where the boiler water foams badly. I found the superheater tubes on the inside practically clean and free from deposit of any kind and not much black deposits in the cylinder and piston heads. The superheaters convert the moisture and water sprayed or carried over with the steam from the priming or foaming water in the boiler, into dry steam, thereby preventing flushing or washing away of the oil from the steam chests and cylinders which oftentimes is the case, besides preventing loss in power of the engine;—or in other

words, you will find, when you have had experience with the use of superheaters in bad, foamy water districts, that you will get much better results from superheated than saturated steam, and that the lubrication will go on much easier, besides using less oil.

While some railroads are using "D" valve or flat or slide valves in their superheated steam locomotives, and claim to get satisfactory valve and cylinder lubrication;—the degree of superheat in these engines is generally low;—high degree of superheat requires piston valves for a successful lubrication, besides for other practical reasons, this I believe is now pretty well recognized.

The next points to consider in connection with the problem of valve and cylinder lubrication of superheated steam locomotives are the methods or manner of feeding, and introducing the oil to the parts to be lubricated. I said in the beginning of my talk that I thought that the question of cylinder lubrication had been pretty well threshed out for many years in connection with saturated or wet steam, but I thought possibly I might find a few points that might be of interest to you.

In the early trials and developments of superheated steam locomotive practice on this side of the ocean, valve oil was fed both to the steam chest and cylinders, using hydrostatic lubricators as well as mechanical pumps in both simple and compound engines.

After getting over the "nervous" tension and gaining more experience in the handling of superheaters and superheated steam locomotives, the number of feeds have dropped down to a minimum. Instead of having, as related in some instances, five to seven feeds from the lubricator in the cab, besides mechanical pumps on some roads they now use for simple engines only one feed into each steam chest, or preferably above the same, into the steam pipe or saddle casting, and none into the cylinders from the lubricator in the cab or as used ordinarily in saturated steam practice, and with compound engines only one feed, namely, into the high pressure steam chest, or above into the steam pipe, discarding the feed direct into the high pressure cylinder and low pressure steam chest and cylinder when working steam, claiming to get satisfactory results. However, when drifting it is good practice to feed some oil into the low pressure cylinder through the drifting valve steam pipe.

One of the most important factors outside of the proper quality of the oil in successful lubrication is the condition in which the oil is introduced into the steam chests and cylinders. If we consider the small amount of oil used and the relatively large surfaces it has to cover or lubricate under the most adverse conditions, the wonder is that so good results have been obtained even with saturated steam. With the era of superheated steam in locomotive service, more attention of necessity has been and will be given to the problem of valve and cylinder lubrication; therefore some years ago the writer began to study the question of how to intro-

duce the oil into the steam and cylinders so as to get the best and most economical results. With this end in view I made some laboratory experiments with a simple atomizer such as used in drug stores for spraying or atomizing perfumes or lotions. Removing the rubber bulb I attached the steam connection, and warming the thick oil a little, it was found very easy to atomize or spray the oil in a highly divided state, like a fine mist mingled with steam, even at an astonishingly low pressure.

This simple atomizer attached to the tallow pipe, such as I used in my first experiments, will show you how easy it is to convert the heavy superheated valve oil into a fine spray or mist.

From this simple method the complete and interesting demonstrating apparatus which I will show you this evening is developed, and you can see for yourselves how simple and easy it is, or will be, to introduce the valve oil in a highly attenuated, atomized form with the live steam into the steam chest or above the same. This method of introducing the valve oil in an emulsified, highly divided or atomized state into the superheated steam gives very satisfactory results whenever tried in practice. I can see no reason why this same method should not be also adopted with saturated steam, both in stationary and locomotive practice.

The next point of interest will be to say something about the requisite qualities suitable valve oil for superheated steam locomotive service should possess. This might be discussed at considerable length, but I am afraid that I have already taken up too much time, therefore I will refer to this all-important point of the problem in a few words.

When you start your engine or train, the condition of the steam is exactly the same as ordinary wet or saturated steam,—more or less moisture or condensation in the steam chest and cylinders. This condition continues for some little time, or until the superheater elements get in their good work, the steam gradually getting hotter and hotter and drier and drier until the requisite or desired superheat is reached. This of course depends on the size and speed of the train, road conditions, etc. This condition to a greater or less extent repeats itself every time the train stops at stations or sidings. Then again we have the condition when the engine is drifting for a longer or lesser time, which also upsets the superheated steam efficiency factor with a direct bearing upon the requisite quality of the oil. This whether the drifting valve with its auxiliary steam pipe for admission of small quantities of steam during drifting, or cracking the throttle, or the use of a by-pass, is adopted.

Therefore the requisite qualities that a high grade and suitable valve oil should possess for the intermittent and variable service conditions existing in superheated steam locomotive service might be tersely expressed as follows:

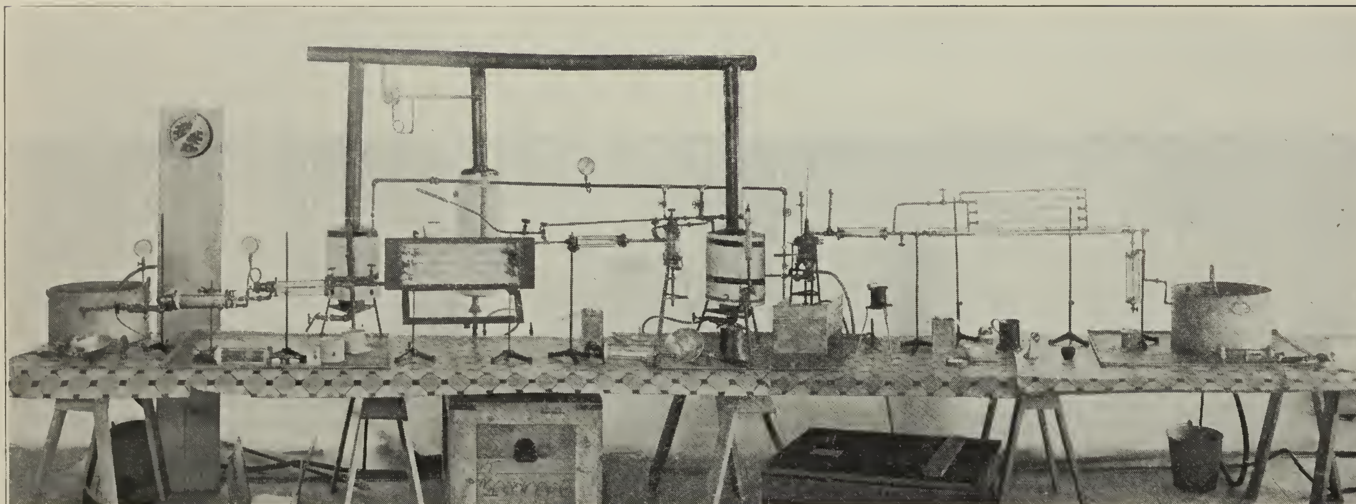

Fig. 1

1st. It should be readily emulsified and atomized with the steam.

2nd. It should have the requisite body or viscosity, with sufficient adhesive property to properly lubricate at the highest temperature found in service without carbonizing, and be free from gummy, tarry and asphaltic constituents.

3rd. It should be elastic, so to speak, so as to fulfill its functions, whether the engine is working under saturated or wet steam conditions, or with the highest degree of superheated steam, or during drifting.

Or, in other words, the oil should be automatic in its behavior, so as to adapt itself readily to the above variable conditions; not too volatile, not too sluggish, readily intermingle in a highly divided state with the steam, and spreading itself in this condition over the surfaces to be lubricated.

I will now briefly describe and explain from the drawings and photographs you see, the construction of my demonstrating apparatus so you will easily understand the working when you see the same in operation.

When we talk "Superheated Steam" we have foremost in our minds the temperature and not the steam pressure; therefore while I cannot or do not have steam pressures as used in locomotive practice I have any degree of temperature corresponding to any desired steam pressure and any degree of superheat that is found, or likely to be had in actual locomotive service and then even much higher, this latter merely to demonstrate and to show you that properly compounded first class valve oil for superheated steam purposes such as I will use in my demonstrations has a very high "factor of safety" above that required in actual service.

Fig. 1.

As you see from the drawings and photographs one of the apparatus consists essentially of steam preheaters and superheaters, a simple hydrostatic lubricator, sectional tallow pipe, of glass tubing, to show the flow and behavior of the oil and steam from the lubricator in the cab to the steam chest at various temperatures. An emulsifier tip inserted in the tallow pipe near the lubricator to show the easy manner of emulsifying the oil with saturated or wet steam;—an atomizer in the tallow pipe as the latter enters the steam chest or steam pipe above, to atomize or highly attenuate the oil already to a greater or less extent mixed or emulsified with steam in the tallow pipe.

The steam chest being represented by a glass cylinder into which not only the tallow pipe with its atomizer, but also a steam pipe for live steam, enters either saturated (wet) or superheated to any desired degree; besides this, a dial thermometer to show the actual temperature of the steam;—beyond this a pressure gauge connection to regulate the back pressure; beyond this another glass cylin-

der connected, representing the steam cylinder where the behavior of the valve oil can be further studied at various steam temperatures, beyond this the exhaust pipe, provided with a valve and pressure, condensor to condense the steam and collect the oil after it has passed through the apparatus.

We can feed one or as many drops of oil per minute as desired with more or less steam through the tallow pipe;—you will see the rate of flow and condition of the steam and oil mixture in a more or less emulsified form—showing the effect of a choke plug or preliminary emulsifier at the upper end of the tallow pipe next to the lubricator. By opening wide or partly closing the valve on the steam pipe leading to the lubricator and tallow pipe the velocity or rate of flow of the oil mixture is easily regulated, and when this steam valve is closed, the mixture remains stationary and probably in the same condition for a long time. As soon as the valve is opened again the flow of the oil mixture or emulsified oil begins;—this condition undoubtedly exists in actual practice, provided the valve in the steam pipe leading to the lubricator in the cab is shut off before or at the same time the oil feed from the lubricator is shut off. If this practice is not followed, that is, leave the valve in the above mentioned steam pipe open for a period of time after the oil feed is shut off, the steam passing through very soon drives the oil mixture out of the tallow pipe and in starting your engine again it takes more or less time before any oil reaches the steam chest and cylinders. In such a case of course it is advisable to start the oil feed before starting your engine so as to be sure to have enough oil in the valves and cylinders. I will clearly demonstrate this.

Fig. 2.

The other apparatus is to demonstrate the behavior of valve oil in extremely high superheated steam temperatures up to 800 to 1,000° Fah., or at ordinary saturated steam temperatures. As you see from the drawing and photographs it consists essentially of a steam superheater, a lubricator, oil filling cups, steam vessel, containing a dish into which oil is fed or poured, a wide glass cylinder with a small boat or vessel and sectional glass tubing system which interestingly shows the behavior of the oil and steam under the above conditions. Beyond this is connected an oil separator, condensor and oil cup to collect the oil after it has passed through the apparatus.

In demonstrating, the oil is either fed drop by drop from the sight feed lubricator into the small dish in the steam vessel or chamber, or the oil is poured into the oil cup above, and from there by opening the valve goes into the small dish;—in the latter case the steam is shut off while the oil flows in.

To demonstrate how the steam can push the oil through the sectional glass tubing system without mixing or emulsifying with the

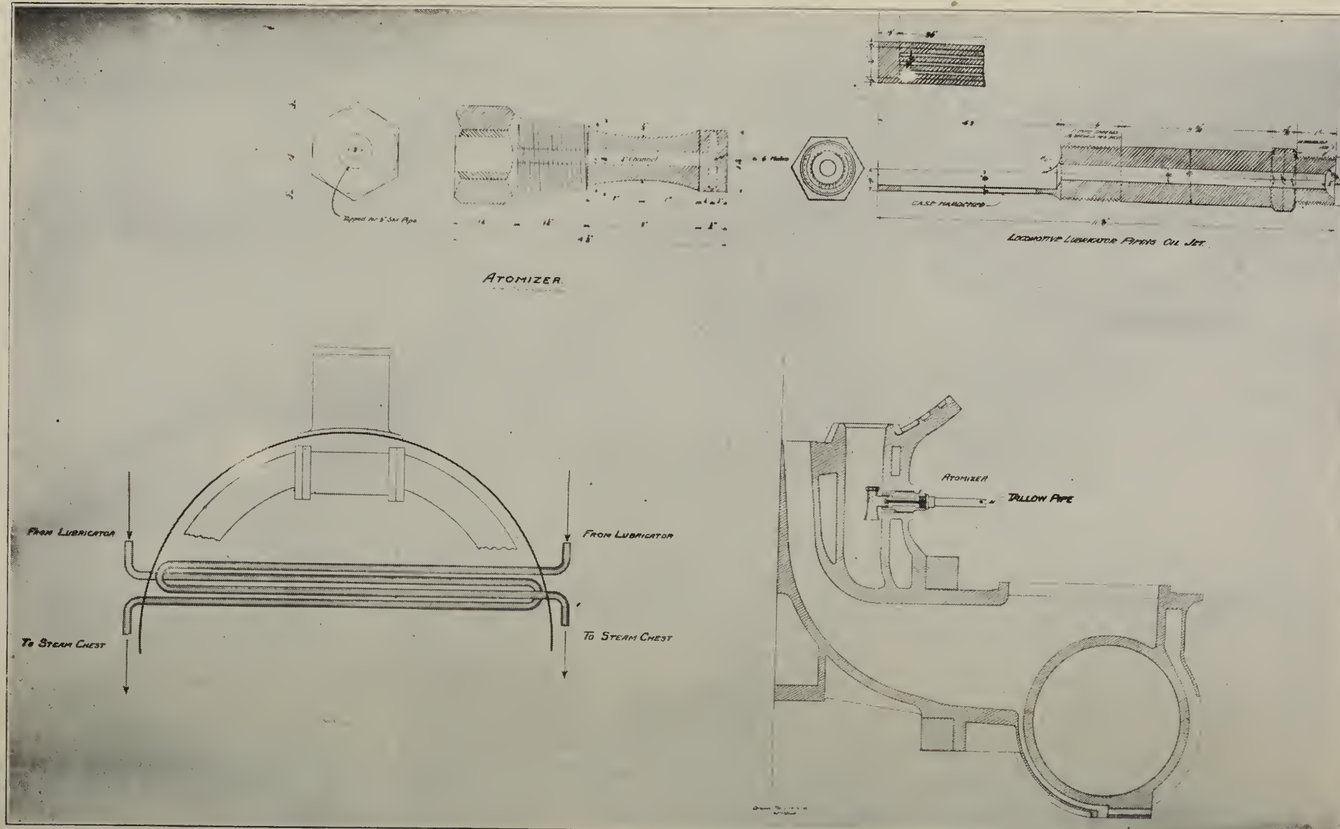
ATOMIZER
LOCOMOTIVE LUBRICATOR PIPING OIL JET
CASE HARDENED
FROM LUBRICATOR
FROM LUBRICATOR
TO STEAM CHEST
TO STEAM CHEST
ATOMIZER
TALLOW PIPE

Fig. 2

latter (oil) the small boat in the glass cylinder is filled with oil and the steam turned on.

From this brief description of my two apparatus you can easily follow the demonstrations, and note the behavior of the valve oil, especially at the higher and highest steam temperatures.

Gentlemen, I have now briefly gone over our subject and thank you for your kind attention.

The President: Are you going to start your apparatus Doctor?

Dr. Conradson: It is going now. I don't know whether the gentlemen want to ask some questions before we start with our demonstrations.

The President: Are there any questions?

Mr. C. A. Seley (C. R. I. & P. Ry.): Mr. Chairman, before entering on the discussion, I think we are to be congratulated on the announcement on the wall, which indicates that the Western Railway Club has been recognized as a technical association by the people who have this exhibit and other facilities for meetings of this kind. Now on the subject at hand, I wish to ask the Doctor if there is any essential difference in your apparatus than was shown at the Traveling Engineers' Association. As I understand the matter, the subject of carbonizing the oil, burning the lubrication, in common language, was a bugbear in regard to the early use of superheat. We thought we had to have extra oiling facilities on our locomotives, which I believe has been thoroughly demonstrated to be the wrong idea, and that this apparatus will show conclusively that temperatures up to and exceeding 800 degrees will not deteriorate the lubricating qualities of the oil. If that is understood, I think it will help, perhaps, some of us who have already seen the demonstration, and help the rest of us who have not had those opportunities for getting perhaps a fuller knowledge on the subject.

The President: Do you wish to answer Mr. Seley's question, Doctor?

Dr. Conradson: Yes. Well, Mr. Seley, there are only a few additions. In the apparatus I had at the Traveling Engineers, I did not have this glass sectional tubing system in here (indicating), I think that will demonstrate a little better. Instead of having the oil and the steam at that high temperature go through this pipe, I let it go in through here, and that will show more interestingly. In this apparatus here (indicating) I have added another glass cylinder, to show when the temperature in the steam chest is very high and the oil comes in, in an atomized form, entering the steam passages, in the saddle casting, passing through the steam chest and getting into the cylinder, how it takes effect, showing that while the oil to a certain extent changes from the fine or highly atomized form into a more coarse-grained form, so to speak, still it is in a very attenuated state. Then I have added these pressure gauges here to determine the amount of back pressure. I found, that sup-

posing I have only say fifteen or twenty pounds of steam pressure on in the live steam pipe here in the steam chest, I can have on the back pressure say about two to four pounds less than the steam pressure from the boiler, and I can atomize and feed the oil equally well. Or, in other words, I find that it requires only a very few pounds more of steam pressure in the oil pipe to drive the oil into the steam chest or steam passages.

Now, that is a very good question to bring up, Mr. Seley, for the reason that it has been found by measurement, I believe, that the steam pressure in the steam chest is any way from six to ten or twelve pounds less than the boiler pressure, therefore with superheated steam it is easier to lubricate or get the oil into the parts that have to be lubricated than with saturated steam. In connection with that, here is a drawing (indicating). I have mentioned the importance of introducing the oil in an atomized or highly diluted form into the steam chest or steam passages, and through the courtesy of one or two roads I have got some devices that they are using and that may interest you. This is a device which was kindly lent me by the Lake Shore Railroad, and I understand that they are getting very good results from using it. As you will notice from the drawing, it connects up with the tallow pipe and screws in above the steam chest or saddle casting, whatever it may be, and set in this direction, and the steam in the live steam pipe comes this way, that is, at right angles. As the more or less emulsified oil mixture in tallow pipe, reaches the spoon like, in the bottom perforated extension, the live steam so to speak licks it up and to a greater or less degree attenuates the oil particles, and probably to quite an extent lubricates the steam.

Here is another device which was kindly sent me, and I understand is in use on one of the Northwestern railroads, the Soo Line. It is a pipe screwed into the saddle casting or the steam pipe above, and connects up with the tallow pipe. There is about an eighth of an inch bore through here, and near the end at right angles to the bore are numerous small holes. This is also set at right angles to the passage of the live steam. The idea is to divide the oil mixture into very minute particles, and that is the thing which I am preaching, to get the best results. You will see when you examine the apparatus here that the oil comes out in a fine spray, and naturally, as I stated in the beginning of my paper, from the small amount of oil used and the large amount of surface to be lubricated, it is essential that the oil should be diminuted to a very large degree.

On this drawing here, which I found in the proceedings of the Railway Club of New York, some months ago, part of the tallow pipe is put inside of the smoke box so as to heat the oil mixture in the tallow pipe before it gets into the steam chest. I think that is a very good idea, in fact I had that in view before I saw this. One of the purposes of my apparatus is to superheat or heat the oil mixture in the tallow pipe before it gets into the live steam. Here

is another device also, a narrow pipe attached into the steam passages of the saddle casting, practically an atomizer, giving very satisfactory results in service.

THE PRESIDENT: Any other questions, gentlemen?

MR. W. E. SYMONS (CONSULTING ENGINEER): Mr. Chairman, this is quite an interesting subject, on which a few thoughts occurred to me that I jotted down in memorandum from which I will speak. Following this I will ask the Doctor a question or two. The whole question resolves itself, you might say, into two branches, first the engineering question, with reference to the proper lubrication of the locomotive; the second is an economic question, or a question of finance.

As the Doctor has already said, when superheated steam was first used, as many of us know, the most of us got a little touch of what is commonly called "stage fright," and to overcome the difficulties we resorted to a very liberal application of oil. In fact, the engines were given, I guess, as a rule, much more oil than they needed. I recall the testimony or the remarks of a member of the Traveling Engineers' Association a year ago, wherein he stated that they had given the engines on their line more than twice as much oil as they needed for a long period of time, until they found out what was actually needed to properly lubricate them, following which they were getting along with less than half the amount.

In the various reports on, and discussions of, the question of Lubrication of Locomotives before Railway Clubs, Traveling Engineers, Railway Master Mechanics, and other Engineering Societies, there has been much stress laid on the apparent difficulty experienced in securing proper lubrication of engines equipped with superheaters, owing to the high temperature of the steam, the difference being somewhere within the following limits:

SATURATED STEAM.

Steam Pressure	Temperature
160 lbs.	364 Fahrenheit
180 lbs.	374 Fahrenheit
200 lbs.	382 Fahrenheit
220 lbs.	390 Fahrenheit
230 lbs.	394 Fahrenheit

While with a superheater and boiler pressures of 150 to 180 lbs. the temperature is raised from 50 or 60 to as high as 200 to 240 degrees Fah. steam chest temperature.

The superheaters that only increase the temperature 50 to 80 degrees, however, cannot be said to offer much difficulty in the matter of lubrication, or effect much if any net economy in operation, while those that superheat up to 520 to 580 degrees not only save considerable fuel but have caused some trouble in the matter of lubrication.

In the report of the Committee on Superheaters to the American Railway Master Mechanics' Association in 1910 this point was brought out by one speaker with reference to the cutting of slide valves; while another, and I may say one of the best authorities on superheat, spoke of having to renew piston packing rings oftener in superheater engines. This subject has been touched upon by the Doctor, and doubtless will be again referred to.

The question of lubrication has of course come up in all these discussions. One member (L. S. & M. S. Ry.) stated they had two piston valve superheated engines, and used twice as much oil as on saturated steam engines, adding they experienced no difficulty in lubricating the engines successfully, which would confirm the statement made by the gentleman I quoted, that originally they gave the engines more oil than was absolutely necessary, and I think one of the points that was brought out this evening that has been or will be demonstrated before the Doctor has finished, is that the work of the Oil Company, in conjunction with the Railway officers, has found a way of avoiding an unnecessary waste of lubrication on engines.

The American Railway Master Mechanics' Association Committee on Lubrication of Locomotive Cylinders, at the convention of 1911, covered this ground pretty thoroughly, bringing out many valuable points in connection with the difficulties encountered in the lubrication of engines using superheated steam.

In reply to the inquiry with respect to the lubrication of locomotive valves and cylinders using superheated steam the answers were to the effect that:

> "There is no difficulty whatever in obtaining satisfactory lubrication in superheater engines with hydrostatic lubricators on account of difference in pressure between steam chest and boiler. In fact, there is considerably less difficulty than on engines using saturated steam. In spite of this, however, the piston ring wear is far more rapid."

Again, in closing, the committee used the following language with respect to Mallet type compound locomotives:

> "The problem of satisfactorily lubricating with Mallet compound locomotives is still in process of solution. At present it seems essential to pipe independently into the high and low pressure cylinders. However, your Committee has been advised that there has been some experience with satisfactory results by eliminating the pipes to the low pressure valves and cylinders, substituting an auxiliary pipe to the receiver with the high pressure steam connection. This carries sufficient oil over the low pressure cylinders to insure good service."

On that particular feature I would be glad to have the Doctor amplify in his closure, so far as he can, as to his knowledge of the progress made with respect to Mallet engines. One member spoke of having 50 engines with steam temperature about 535 to 565 de-

grees, on which they tried the mechanically operated lubricator and found it unsatisfactory. It may be fairly assumed that these engines were of the consolidation type using superheated steam.

From the foregoing it would appear that the question of satisfactorily lubricating the valves and cylinders of locomotives using the higher steam temperatures has not yet been definitely solved on all roads, and that while some lines may have, as a result of experiment, reached a satisfactory solution, others have not yet progressed quite so far, so that the field is still open, affording an excellent opportunity for the mechanical officers in conjunction with the officers and experts of the Oil Company, also the manufacturers of lubricators, to work out on a practical basis a thoroughly systematic plan for lubricating the valves and cylinders of the different types of locomotives using steam pressure of varying temperatures from, say, 358 degrees at 150 pounds up to as high as 394 degrees at 230 pounds steam, using saturated steam, while by superheating these temperatures may be advanced to 520 to 580 degrees and in some cases to as high as 600 degrees.

The very valuable and interesting work of Dr. Conradson, together with others who have bent their energies in the direction of solving this very important problem, have borne much fruit, and the continued co-operation of all parties at interest will undoubtedly result in great benefit to the railway companies, for without the co-operation and assistance of the manufacturers of lubricating devices, together with the very extensive and, I may say, expensive laboratory facilities and expert department of the Galena Signal Oil Company, which are always at the disposal of the railway officers, there would have been much less progress made than has been, and doubtless in many instances mechanical officers would have been somewhat handicapped if left to solve these problems all alone.

The Traveling Engineers' Association in 1911 had a very able report on: The Lubrication of High Pressure and Superheater Locomotives and Methods of Introducing Lubricant between the Surfaces," from which I quote the following:

"Low superheat using the smoke-box type does not exceed 490 degrees.

"The Baldwin Superheater shows 430 degrees, which is only about 140 degrees added to saturated steam.

"Oil has been changed even with low superheat to flash point of 520 degrees.

"The mileage per pint ranging from 35 to 75 miles.

"High superheat calls for oils with flash point of 550 to 600 degrees Fah. Some eight (8) different lines reporting steam temperatures of 490 to 590.

"Much valuable information on the questions of lubrication, life of packing rings, etc."

From the remarks of some of the speakers it would appear that engines using superheater steam were both difficult to lubricate and rather expensive on certain items of repairs. From others, however, who had thoroughly learned their lessons in the school of experience, it is learned that the lubrication of high temperature superheated engines of the Mallet type is not a difficult problem, and that many of the troubles at first encountered, and in some instances charged to the lubricator or the Oil Company, were largely imaginary, especially in the item of lubrication, the quantity of oil in some cases having been just about cut in half after the first effects of what might be termed "stage fright" had passed off and the matter was brought down to a practical working basis.

In all of this work the lubricator people and the Oil Company have, even when not at fault for existing troubles, cheerfully cooperated with the mechanical officers of our railways with a view of assisting in their solution, and the references which I have quoted bear excellent testimony as to the results already achieved, and Dr. Conradson's most interesting and instructive lecture is replete with evidence of the Oil Company's ability and desire to continue spreading the gospel of lubrication.

I have arranged in tabulated form some statistical data in reference to certain hypothetical engines, and I will go over some of the figures, and ask the Doctor if he will, in his closure, put me right if I am wrong, as to area or costs.

Taking an engine, with cylinders 20x26″, there are about 3,318 square inches of lubricating surface in the two cylinders. With a 74 inch drive wheel, an engine makes 273 revolutions per minute, the wearing surface covered by the pistons in a mile would be 1,783,236,000 square inches of wearing or lubricating surface. If the engine made 100 miles to a pint of valve oil, the cost of valve oil would be 62 cents at 50 cents per gallon, and the area surface lubricated for one cent, would be 28.531.776 square inches. I will pass from the first example, and submit the table to be incorporated in the proceedings.

The fourth on the list is a Mallet type of engine, with cylinders 28x38x32″, the wearing surface or area of all cylinders in inches is 14,701 and with 57″ drivers making 350 revolutions per mile, the wearing surface covered by the pistons in 1,000 miles would be 10,290,700 square inches, and if the engine made 30 miles to a pint of valve oil the cost for valve oil would be $2.08, and the area of the surface lubricated for one penny would be 49,474.519 square inches.

The tabulated statement submitted by Mr. Symons is as follows:

HYPOTHETICAL CASES TABULATED

TYPE OF ENGINE	Size of Cylinders	Wearing Surface or Area of all Cylinders in Inches	Diameter of Drivers and Revolutions per Mile		Wearing Surface Covered by Pistons Each Mile and Each 1000 Miles		Mileage to Pint of Oil, Gallons per 1000 Miles Run and Cost per 1000 Miles for Valve Oil. Number Inches Wearing Surface Lubricated for One Cent.			
			Diam. Drivers in Inches	Revolutions per Mile	Wearing Surface of Pistons Each Mile	Wearing Surface of Pistons Each 1000 Miles	Miles to Pint of Valve Oil	Gallons Per 1000 Miles Run	Cost per 1000 Miles for Valve Oil 50c per Gal.	Number Inches Surface Lubricated for One Cent
(8 Wheel) American	20x26	3.318	74	273	1.783.236	1.783.236.000	100	1.25	$ .62.5	28.531.776
Pacific	22x28	3.890	78	258	2.007.466	2.007.466.000	80	1.56	.78	25.736.743
Consolidation ..	23x32	4.624	60	339	3.135.072	3.135.072.000	60	2.08	1.04	30.144.923
Mallett	28x38x32	14.701	57	350	10.290.700	10.290.700.000	30	4.16	2.08	49.474.519
....	....	....	......	......	....	....	20	6.25	3.12.5	31.663.692

W. E. Symons, 3-19-12

I take it from the testimony given by the different members of Engineering Societies and Railway Clubs, with reference to the quantity of oil used, that more than twice, and in some instances three times, the quantity of the oil I have quoted was originally used on the Mallet type engines using superheaters. Therefore, if through the results of the work of the lubricator companies, the Oil Company and the mechanical officers of the railways combined, it has been reduced down to the present figures, the result of the Doctor's labors in conjunction with others has already effected a great economy in the use of oil, in addition to the benefits experienced from an engineering or mechanical standpoint in the matter of repairs, and also in having the use of the engine more steadily than if it was in the shop on account of warm cylinders, pistons, valves, valve gear, etc.

In further reference to the financial feature, in connection with this subject, I recently prepared some figures on the item of saving effected in economy of lubrication of railways, in which I estimated that if the cost of lubricating oils on our railways had advanced in proportion to the cost of labor and all other materials, that it would be fair to assume at the present time that the cost per thousand miles for lubricating locomotives and cars would be about as follows:

Locomotives	$6.00
Passenger Cars	.60
Freight Cars	.30

These figures compare favorably with other cost items in railway operation.

As a matter of fact, however, the cost of lubrication has gradually decreased while other similar items of expense have increased. The average cost per thousand mile run on all lines is not known, but it may be conservatively estimated as follows:

Locomotives	$2.50
Passenger Cars	.12
Freight Cars	.05

and on this basis the railways are saving approximately $10,000,000 per year, which is largely due to the efforts of the Oil Company.

In addition to the foregoing items many thousand electric headlights have been placed on locomotives in recent years, lubrication for which the Oil Company has furnished without extra compensation. This item has been estimated to exceed $25,000 per year, and it would be quite interesting if Dr. Conradson, or any railway officer, will kindly modify or confirm these figures.

Dr. Conradson: I have listened to Mr. Symons' remarks with great interest in regard to the economical use of oils, lubricating locomotives in railway service, cars, etc., and while I would like to take that matter up in detail, time is flying, and we have to go on with our demonstrations. However I will simply say that Mr.

Symons' carefully prepared statements are good to listen to, because they show what first class lubricating oils, properly applied, and looked after in service, in accordance with methods introduced by the Galena-Signal Oil Company through its practical men in the field and in co-operation with the mechanical officers and others of the railways, can accomplish. This question alone, we might profitably some time take up for our subject for discussion, but I have to go on.

I only want to take up and reply to one point that has a direct bearing on our subject this evening, and that is on the Mallet type of engines which have come under my observation. On Mallet engines on a road in the Northwest they started in with direct oil feeds into the high pressure steam chests and high pressure cylinders and low pressure chests and cylinders from hydrostatic lubricators in the cab; besides this force feed pumps were also used. They were working these engines for some length of time, when one of the Mechanical Experts belonging to my company began to study the question whether it was necessary to have so many feeds to properly lubricate this particular type of engines, and we wrote him a while ago to see what has been accomplished within a year or two, and I will quote from what he writes:

> "Superheat Mallet that came with force feed pumps to the low pressure cylinders and hydrostatic lubricator to the high pressure cylinders, would advise the force feed pumps have been taken off and an oil pipe leading from the lubricator in cab is connected to the back end of low pressure receiver pipe. This oil pipe we can run through the drifting valve pipe, the drifting valve pipe being connected to the back end of low pressure receiver pipe. When working steam the majority of our engineers do not use this oil pipe to the low pressure cylinders, only using same when drifting."

That means that where they had six feeds in addition to the mechanical pumps; to-day they have only one feed, and that goes to the steam pipe in the saddle casting, or in the steam pipe above the high pressure steam chest, and when the engine is working that is all the oil that engine gets, and it works satisfactorily and economically. I think that Mr. Symons' remarks have brought out ideas of what economy means in lubrication of locomotives and cars in this country when he states that to-day they are lubricating at a cost to the railroads of five millions, whereas if the cost of lubrication had increased in the same ratio as other commodities and materials have increased it would to-day cost the railroads fifteen millions.

The President: Any further discussion, or questions to ask the Doctor?

Mr. Willis C. Squire: Mr. President: I feel that Dr. Conradson has not dwelt sufficiently upon an important matter that is referred to in his paper. It appears to me that further devel-

opment of the problem of efficient lubrication lies in the high degree of atomization of the oil under the high temperatures found in superheated steam. Under the conditions he has explained to us, and it is evidenced in the apparatus before us, the entire body of steam carries in suspension a certain amount of or proportion of lubricant, the vaporizing or atomizing temperature of which is greatly in excess of the medium in which it floats or is held in suspension. By inference one would suppose that only that portion of steam coming in direct contact with the metallic surfaces of the cylinder gives up a certain proportion of its oil, due to the relative cooling effect of such contact. The atoms of oil by this temperature change become larger atoms, and the further change to a globular form takes place because of the loss of heat due to the expansion of the steam. It would be reasonable to suppose that the oil is actually precipitated in the form of a mist, lodging on the walls of the cylinders and pistons in a very thin film as does water under certain atmospheric conditions. A similar condition is found in foggy weather.

I wish to inquire further of Dr. Conradson if it has been shown by his experiments that these conditions have been duplicated or if he has reasons to believe they are duplicated in the cylinders and steam passages. If this analysis is not correct then it is reasonable to suppose that at least 99% of all oil fed to the cylinders does no useful work, and is exhausted into the atmosphere with the steam passing out of the cylinders.

The idea presented seems to me to be the true solution of the process of lubrication, as gases act in the same manner under varying temperatures, be they relatively high or low. Another suggestion is presented by the foregoing: It is comprehendable that the contraction of the steam vapor due to its contact with the cylinder walls induces a circulation to occur within the cylinder content, thereby causing a flow of the gas or steam to that point or surface which would mean a much larger proportion of the steam coming into contact with the cylinder walls than is usually considered to be the case. This reasoning is susceptible of proof, because no matter at what speed the steam may sweep through the ports, passages and cylinders, there are the same counter currents within the steam mass that would occur in ordinary cloud or vapor masses suspended in air currents under atmospheric pressures.

If 99% of the oil is actually lost would it not be possible to increase the efficiency of the lubricant passed into the cylinders by more closely studying the problem along the lines of this suggestion?

Dr. Conradson: That is a very good question to bring up. Now I think I can with this apparatus answer your question. Assume that the steam in this pipe is at a certain temperature at the beginning of the stroke; that they have a high steam tempera-

ture as the steam comes from the steam chest, perhaps only 20 or 50 degrees below the temperature you start with, tha initial temperature. As the pistons move forward or backward the pressure diminishes and the temperature goes down in the same ratio. As the temperature goes down, towards the end of the stroke, the atomized oil, which I can show you in this pipe, separates from the steam and forms into very fine particles and settles on the surface of the cylinders and there of course it does good work as far as it goes. Now you have to remember, gentlemen, you are feeding one pint of oil, running 50 or 75 or 100 or 150 miles, whatever it may be. Most of the oil goes out at the exhaust, very little of it stays in, hardly any. So that considering the problem of lubrication from a scientific point of view, it is very hard to solve the problem of understanding how that small amount of oil can keep the surfaces apart, that is, to overcome friction to a large extent and the rapid wear. Now we advocate this, as I said before, and I am glad to say that there are quite a number of railroads that fully realize the importance of atomizing or attenuating the oil in the tallow pipe as it enters the steam chest or saddle casting, and therefore these devices are in practice to-day and the roads that are using devices of this kind, claim that they get much better lubrication, that is, they get much less wear on the piston rings and the bushings, showing that the oil has got a better chance to do its work, or, in other words, the idea of atomizing the oil is to lubricate the steam, and I have over and over again when I have got the temperature proper, seen how the oil, while it is in an atomized form at the beginning of the stroke, as it enters the cylinder begins to spread out, and on the back stroke there is always some oil present between the cylinder walls and the pistons, and these therefore of course will get more or less lubrication on that account.

Mr. Squire: I would respectfully inquire further of Dr. Conradson that if the case is as he has stated it, has he at any time during the course of his experiments investigated or determined the actual oil content of the steam per cubic foot as it passes out of the exhaust? That is, has he ever determined the actual degree of saturation of steam with the oil as it enters the steam chest at the higher temperature compared with the degree of saturation of the steam as it leaves the cylinders at the exhaust? Could there be any valuable information derived from such an investigation or could any greater lubricating efficiency be secured by a definite knowledge of the two values in question?

I am still inclined to the belief that the relative condensing value of the cylinder walls and passages taken into consideration with the drop in temperature due to expansion of steam, would cause an apparent precipitation of the oil held in suspension and give an increased amount of lubrication of the wearing parts which means economy in lubrication, as well as decreased wear of

those parts in rubbing contact. A study of the question along these lines might develop a different class or type of lubricating oil which would be suited to the requirements not only of superheated steam but of saturated steam as well.

Dr. Conradson: My explanation to Mr. Squire's first question applies in a general way to his last question. I have made no direct and definite determination as yet, as to the actual degree of saturation of the steam with the lubricant as the time the former enters the steam chest, and leaves at the exhaust. Such investigation might be possible, although I take it rather complicated. However, for all practical purposes I might say, as the steam enters the steam chest mingled with the highly attentuated or atomized oil, and both being at a high degree of temperature, the steam unquestionably is to a greater extent, saturated, or lubricated with the oil, than it is or would be at the exhaust,—because as stated before, at the beginning of the stroke the temperature is highest, and lowest at the end. As soon as the temperature becomes materially lower, the microscopic oil globules or mist begin to settle out from the steam unto the walls and other parts of the cylinder.

That this is the case I will clearly demonstrate to you with my apparatus later on, and it is interesting to note the behavior of a mixture of superheated steam and oil, especially at very high temperatures such as I will use in my demonstrations, when you will see, or rather not see the mixture of the steam and oil passing through the sectional glass tubing system. However as soon as I shut the steam off, the glass tubings are filled with a fine gray mist of oil particles that were intermingled with the steam, but not visible until the steam is shut off. As the walls of the glass tubings momentarily cools somewhat, you will notice the oil mist begins to move or draw towards the glass surfaces, and if the latter become sufficiently cool, the oil separates to a larger extent, forming a complete coating or film. This takes place in actual service. From this you will readily understand that the steam at the exhaust is less saturated or lubricated with oil, than when it enters the steam chest. I don't know whether I have answered you question very clearly.

Mr. Squire: You have answered it.

Dr. Conradson: I think when I demonstrate in my apparatus what I have tried to tell you, you will see better than I can tell you in a few minutes.

Mr. A. R. Kipp (Wisconsin Central R. R.): Mr. President, I think that these experiments rather show us how the oil comes through that is held in suspension in the steam, or that part of the steam, that does not come in contact with the cylinder walls or the pistons. Does that part of the oil that comes in contact with the walls of the cylinder and forms a filament between the two pieces of metal that gives us the lubrication, come out again

in the same form as this oil that you are showing in the experiment, or does that oil come out with particles of the iron that are worn off, or other particles of dirt that might be in the cylinder, and form these particles that we have seen in the bottles you have passed. In other words is the oil that is doing the work affected by the excessive heat?

Dr. Conradson: After the oil passes through the steam chest and cylinders into the exhaust, the same (oil) is more or less contaminated with metal wearings, and other foreign materials that may be present from the steam, or particles of dirt or ashes, etc., if smoke stack gases are drawn in during drifting.

The President: Are there any further questions to be asked? Mr. Bentley, anything you are interested in on this?

Mr. H. T. Bentley (C. & N. W. Ry.): The paper presented by Dr. Conradson this evening has been very interesting and instructive, the subject being a particularly live one with most of us just now.

The use of superheated steam in locomotives has brought up problems that are gradually being solved, the question of lubrication having been one of the greatest we have had to contend with. At one time the results we obtained were not at all encouraging and the lubricator manufacturers were kept busy trying to explain why we were cutting bushings every trip and wearing out rings just about as fast as we could put them in,—it certainly was not the small quantity of oil used, as we were filling lubricators at every possible opportunity.

We were rather short of power when our first superheaters came which caused us to pool the engines and one trip a man would be on a superheater and the next on a saturated steam engine, which caused us lots of trouble and at times we almost felt as if we had a white elephant on our hands. We now have 95 engines equipped with the Schmidt superheater and 60 more coming and, as we are able to put regular crews on those we have in service, the men are becoming more familiar with them and our troubles are decreasing.

It was thought that, under the high temperature, the oil carbonized, but from what we have seen with the apparatus shown and described so clearly by Dr. Conradson, the oil we are using will stand a greater degree of heat than is ever obtained in service. To assist the oil in performing its function and keeping the cylinders moist and free from front end gases and dust, the best results are obtained by either using a drifting valve or running with throttle slightly open until engine comes to a stop and the sooner this fact is realized the quicker will good results be obtained.

The President: Professor Smith? Professor Endsley?

Prof. L. E. Endsley: (Purdue University): Down at Purdue we have had an American type slide valve locomotive in

which we have been using superheated steam for several years, and while everyone seems to think that a slide valve can not be used on a superheater locomotive, we have had no trouble. This is no doubt partly due to the fact that our locomotive does not drift, as do locomotives on the road, for when we shut off steam, the locomotive immediately stops as there is no train behind the Purdue locomotive to keep it going after the steam is shut off. In this way, the evils that arise on the road, due to drawing in dust, cinders and the like from the exhaust and the gases are entirely done away with. Also, as the locomotive at Purdue was built some fifteen years ago, the composition of the iron in the valve and cylinder may be of exceptionally good material. During the tests with superheated steam, we have used a good grade of oil having a flash point at about 600 degrees. So while I do not wish to advocate a slide valve for locomotives using superheated steam, I can say that for some reason, possibly due to luck, we have not had any trouble with the locomotive at Purdue while using this type of valve.

In regard to the number of oil feeds necessary, I can say that when the superheater was first installed in the locomotive at Purdue, we had two oil feeds to each side of the locomotive, one to each valve box and each cylinder. The tallow pipe to the right cylinder burst one day just before starting a test, and rather than lose the test, we put a blind gasket in each end of the tallow pipe and ran the test. After the test, we took off the right cylinder head and found the cylinder wall in just as good condition as before, and during the remaining two years of testing on that superheater, only one feed was used to the right side.

Just at present we are obtaining about 640 degrees temperature in the valve box.

Mr. C. D. Young (Engineer of Tests, Penna. R. R.): I did not expect to say anything, although this is a pretty live subject with our road just at the present time. We have a number of superheater engines which are operating, and operating quite successfully, due to getting after some of the troubles and cleaning them up as they came along. To point out to you the service in which our engines are running, I might say that our superheaters are on our heavy passenger engines hauling heavy steel trains between New York and Harrisburg. The temperature of superheat runs about 650 to 660 degrees in the steam chest. We are using a superheater oil which is furnished by the Galena-Signal Oil Company. We did experience some trouble with the valves on the superheaters at first, due largely I think to the inexperience of the men operating the locomotive. When the locomotive was drifting, because of a green stop signal, the throttle was shut. This resulted in lubrication troubles but after instructing the men and explaining that there must be some steam passing through the cylinders all the time, that trouble has practically disappeared, and we are getting along very nicely at the

present time with our superheater engines, which are hauling our fast and heaviest trains.

There are a number of things that I would like to have explained to me by Dr. Conradson to-night if I might, or at least to get his opinion on them, as he has followed this subject up pretty closely and for a considerably longer time than our road. It is the practice, I believe, in Germany, to use a forced feed lubricator on their superheater locomotives, whereas in this country I believe the prevailing practice is to use the hydrostatic lubricator. I would like to ask him whether he has any preference between the two methods of lubricating for the saturated or superheated steam. He has dwelt upon the atomizing of the oil before it passes into the cylinder with special atomizers. As a general scheme I think I can agree that that is the proper thing to do, but I would like to ask him if in his opinion he does not think that if the oil is introduced a sufficient distance back of the valve in the steam way so that it will have time to mingle with the steam before it enters the valve, if about the same results cannot be produced, and if such an application would not eliminate the arrangement which has been used in the South by heating the oil in the smoke-box. When you consider the total heat in the steam passing the discharge of the oil in the steamway, as compared with the volume of the oil which goes into the steam-way, it seems to me there is ample heat there to vaporize that oil between the outlet of the tallow pipe and the valve to fully take care of heating the oil and bringing it up to the temperature of the gas.

I would also like to ask him if in his opinion the by-pass valve is an essential feature for a superheat locomotive. Our locomotives are operating at the present time without by-pass or pressure valve.

One other question that I would like to have answered is whether he considers a five, ten or fifteen per cent. fat oil the proper per cent. of oil for super-heated steam locomotives, and whether it should be lard or tallow oil; what grade of petroleum stock should be used, whether it should have the asphaltic or tarry matter entirely removed, and if not what per cent. would be tolerated in the petroleum.

We have been making some experiments in our locomotive testing plant, running about 650 degrees superheat, and we find that the temperature of the walls of our steam chest is very much higher than the temperature of the walls of our cylinders. We have found a difference of anywhere from 100 to 200 degrees in temperature between the steam chest and the cylinders, that is, in the material itself, and if that is the case, I would like to ask Dr. Conradson what he would consider was the proper flashing and burning point for the petroleum stock that he would use for the oil.

I have more questions I could ask but I won't delay the meeting by asking them. But I would like to say, that in my judgment, with the proper handling of the locomotive, no trouble will be experienced with superheater engines. We have comparatively little, considering our inexperience.

Dr. Conradson: Mr. Chairman, Mr. Young has asked quite a number of questions, and I don't know whether I will remember all in the same order in which he asked them.

I think the first one was whether I consider that mechanical pumps or force pumps are necessary, or whether hydrostatic lubricators would answer just as well, and the difference between the two from a practical service standpoint. I will say that on the two roads which have been quoted with using superheaters on the most extensive scale in this country, that is, in the States and Canada, with their experience for five years, the information I have received lately from those two roads is that they had several hundred force pumps or mechanical pumps besides the usual hydrostatic lubricator when they first started in with superheaters, but every one of those pumps has been taken away, and to-day they are using only the hydrostatic lubricator, and in superheat practice it does equally well as in saturated steam practice.

As regards the necessity of atomizing the oil instead of simply feeding it in in a solid body, or simply drop by drop, I do not consider that the latter practice, that is, not atomizing the oil, is as good as atomizing the same, that is, dividing the oil particles into a very minute size, and mingling the same with the steam before it enters the steam chest. I can readily answer that question by demonstrating with the apparatus over there.

I do not think it is necessary to heat the oil in the tallow pipe as the men in the south do, although I think it is a good thing in certain cases. You can see the oil here as it comes from the tallow pipe (indicating on apparatus). In this state it comes in a fairly good attenuated state, partly mixed with steam, condensed steam, in the form of an emulsion. If that goes into the steam passage above the steam chest it breaks off to a great extent, in fact it atomizes and mingles very readily with the steam, which can easily be demonstrated. On the other hand, if you feed the oil, as is ordinarily done, through a one-quarter or one-eighth-inch pipe in a solid body, the same as it goes through the tallow pipe there now, if you drop it down on to your valve if you have a slide valve it may spread itself and do some good. Then perhaps if a larger amount of oil has accumulated somewhere else, the steam may come and push it off bodily, suddenly, the same as I do here, and you don't get good lubrication. If it enters from the steam chest certainly will have a better lubrication with a smaller amount of into the cylinders in a highly divided state or atomized state, you oil.

As regards the composition of the oils, the flash point, etc., will say that the flash point is one of the least important factors; it may mean much and it may mean very little; it depends so much on the other qualities, requisite in a properly compounded valve oil; you may have a flash point of 600° Fah., and a burning point of 700° Fah., and the same may be a very poor oil for superheated steam purposes. Again, you may have an oil with say 500° Fah., flash point, compounded from suitable stock oils in such a way that it will make a most excellent and suitable oil for superheated steam in locomotive service. You have to remember as I explained or stated in my paper that when you are running under variable conditions as you do on a railroad, with superheated steam, and stop at a station for ten or fifteen minutes, or two minutes or three minutes, whatever the case may be, stop on a siding, it will take you quite a few minutes before you will get the benefit from the superheat elements. If you have an oil that responds to a fire test of 700 or 650, whatever it may be, you may assume that it is a straight oil, and it is so sluggish that you will have a great deal of trouble in properly mingling the oil with the steam as it should be. When the superheat element gets in, then, of course, you can use a higher degree of oil or a higher fire test or flashing test, if you choose to, but a properly compounded oil must essentially contain compounds which will take care of the saturated steam conditions.

I believe those are the essential questions you asked, Mr. Young.

Mr. Young: Now may I ask what viscosity you would recommend with that, what fat, what per cent. of animal fat you would recommend with that combination?

Dr. Conradson: Well, that is a question that I have not gone into very much for discussion. It is a mooted thing. Some have an idea that a great deal of fat is necessary, and some have an idea that they can do without any fat. I think myself that a certain amount of fat is necessary, and in fact I find in my experiments with the machine that to properly amalgamate and atomize the oil with the steam it is essential to have a certain amount of fat oil present.

Mr. Symons: The remarks of Professor Endsley brought to my mind again the habit of using oil in an extravagant or wasteful manner, particularly on a new type of engine.

Some years ago I had some interesting and valuable experience as a Marine Engineer, having been Chief Engineer of a steamship for two or three years.

The question of economy, particularly in the item of lubricating oil was taken up by the management, and not unlike our brethren on land, we thought it our sole prerogative to say how often and in what quantities the "oil bath," either internal or external should be administered.

Knowing the government's liberality in many ways, I sought to strengthen my position by precedent, and with this object in view went on board a government ship equipped with a triple expansion engine with superheater, expecting to find their consumption much greater than my own.

The Chief Engineer of the ship showed me every courtesy in all matters, particularly the items of lubrication. I inquired, "How many gallons of cylinder oil do you use per month?" to which he replied, "We do not use any." "How is that?" I inquired, "and how do you lubricate your cylinders?" "Well," he answered, "we formerly had oil pipes to each cylinder and steam chests and our consumption of valve oil per month was very high, although the principal business of this ship has been to 'lay to' awaiting orders, and occasionally make a short, easy cruise. Some six years ago, however, the question of economy in valve oil was taken up and we took the position that we could not get along with any less quantity of oil. After some correspondence we were instructed to remove the oil pipes and plug up the holes, which we did, and these cylinders have received no lubrication since, except that applied when making adjustments or repairs to the interior of cylinders or working parts."

With this object lesson, I hurried back on board my ship and at once found it quite easy to operate with about one-third the quantity of valve oil formerly used, and still have plenty of surplus oil.

I think Professor Endsley's remarks are a strong endorsement of the general testimony of those who have found that excessive quantities of oil were used on superheater engines, one particular case being mentioned by Dr. Conradson, where a Mallet engine had been using six feeds and a force pump besides.

In mentioning the operation of Marine Engines without cylinder oil I do not want to be understood as advocating the operation of locomotives without oil, for I not only think it impractical, but I understand Dr. Conradson's company is still in the business of manufacturing and selling a very good quality of oil, and I would not be so discourteous to our guest of the evening as to offer any suggestions that might lead to cancellation of oil requisitions and thereby affect the business of the Oil Company. As a matter of fact, I am inclined to the belief that the railways should increase the price paid per thousand mile run of their large engines, especially those of the Mallet type.

Dr. Conradson: You can do it; we will find something else.

The President: Dr. Conradson would now like to have every one pass in front of the machine so that he may explain it in detail and answer any questions you may wish to ask, and I will repeat his invitation to show it to any of you tomorrow if you so desire. Otherwise, we will ask him to take it down.

DR. CONRADSON: I will be glad to remain a couple of days and give demonstrations, for the benefit of the men you may send.

MR. SYMONS: I want to make a motion, if it is in order at present, that a vote of thanks be tendered to Dr. Conradson for coming here and delivering this very interesting and instructive lecture.

THE PRESIDENT: That will be taken as the sense of the meeting.

DR. CONRADSON: Gentlemen, it has been a pleasure to me this evening and I am glad that I came, on account of the large number present and the interest and the attention you have given me, and the valuable and instructive discussions we have had, and I thank you.

(Dr. Conradson then proceeded to further explain his apparatus to the members and give demonstrations, showing the behavior of valve oil and steam in the tallow pipe from the lubricator to the steam chest and cylinders, under varied conditions of saturated steam up to the highest degree of superheat, and at the conclusion of the demonstrations the meeting adjourned.)

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OFFICIAL PROCEEDINGS

OF THE

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The regular monthly meeting of the Western Railway Club was held at the Auditorium Hotel, Tuesday evening, April 16, 1912. Vice-President T. H. Goodnow in the chair. The meeting was called to order at 8 P. M. The following members registered:

Allison, W. L.
Barnes, C. A.
Basford, G. M.
Bjurstrom, G. A.
Blatchford, C.
Borrowdale, J. M.
Brewster, M. B.
Carscadin, C. A.
Chisholm, J. E.
Converse, W. A.
Coolidge, W.
Conrath, P. J.
Constant, E. J.
Covert, M. F.
Cross, C. W.
Delaney, C. A.
Derby, W. A.
DeVoy, J. E.
Dodd, T. L.
Dupree, J.
Fenn, F. D.
Fogg, J. W.
Fugate, F. L.
Gardner, H. W.
Gardner, J. E.
Gilbert, H. H.
Gillespie, A. W.
Gilpin, G. G.
Goodnow, T. H.
Hanson, F. H.
Jackson, O. S.
Jennings, D. F.
Jett, E. E.
Jones, L. E.
Jordan, J. B.
Keeler, B. A.
Kucher, T. N.
LaMar, A.
Lammedee, J. M.
LaRue, H.
Lavis, W. K.
Lawrence, W. J.
Lewis, J. H.
Lickey, T. G.
Lozier, J. A.
Lucas, A. N.
Lundehn, Otto.
Lynch, Geo.
MacAlpine, A. R.
McIntosh, R. S.
Midgley, S. W.
Miller, C. E.
Morehead, L. B.
Morrison, R. H.
Motherwell, J. W.
Nash, J. H.
Nathan, C. A.
Naylor, N. C.
North, L. A.
Olson, O. M.
Osterman, O. M.
Parks, O. J.
Phillips, L. R.
Pownall, W. A.
Pratt, E. W.
Prentiss, G. N.
Robb, J. M.
Rodger, J. H.
Scofield, W. C.
Snow, F. W.
Squire, W. C.
Stark, J. L.
Steele, W. P.
Stoll, W. J.
Taylor, C. O.
Taylor, J. W.
Thomson, Geo.
Towsley, C. A.
Turner, G. S.
Walbank, R. T.
Walsh, W. J.
Waughop, Chas.
Willcoxson, W. G.
Wilson, L. F.
Wolf, Chas.
Windes, T. G.
Woods, E. S.
Wright, W.
Wymer, C. J.
Willets, E. H.
Yergy, H. J.

The Chairman: Gentlemen, the Club will please come to order.

The first will be the approval of the minutes of last meeting. These are in process of being printed, and unless there is some objection filed with the Secretary they will stand approved as printed and sent out.

The next is the Secretary and Treasurer's report.

The Secretary: Mr. Chairman, I have the following membership statement:

NEW MEMBERS

Name	Occupation	Address	Proposed by
T. T. Milar,	Lino Paint Co.,	Chicago	W. D. Hall
Paul A. Bevan,	Amer. Vanadium Co.,	Pittsburgh, Pa	J. M. Lammedee
O. S. Beyer, Jr.,	Mech. Dept., C., R. I. & P. Ry.,	Chicago	H. LaRue
C. A. Liddle,	Am. Car & Fdy. Co.,	Chicago	Andrew Spuis
T. T. O'Brien,	Ter. R. R. Asso.,	St. Louis, Mo	T. H. Goodnow
F. B. Heitman,	M. M., Chgo. Union Trans. Ry.,	Clearing, Ill	J. A. Lozier
B. A. Clements,	Worth Bros Co.,	Chicago	T. L. Dodd

MEMBERSHIP

Membership March, 1912		1,540
Dropped	81	
Resigned	34	
Dead	2	117
		1,423
New members approved by Board of Directors		7
Total		1,430

The Chairman: Before taking up the report of the Committee and the paper of the evening, we have with us this evening Mr. Godfrey W. Rhodes, one of the earliest members of the Western Railway Club, and I am sure we will be glad to hear from Mr. Rhodes before we start the regular program. Mr. Rhodes was President of this Club from 1887 to 1889. (Applause.)

Mr. G. W. Rhodes: Mr. Chairman, it is so long since I have been thrown in with a body of railroad men that I think I am quite out of the line of your general talk. As you probably know, I gave up my railroad work about six or seven years ago, and have been living in England and traveling on the continent since then. When I came back to this country about three years ago I felt fairly close to my old friends and visited a good many of them. But this time I feel further away from them and I have not visited quite as much. The reason is that I feel that I am not up in railroading; the many things that I ought to be conversant with I am not conversant with now. When I look at your engines and look at your steam cars I just shake my head and wonder what would we have thought of building such heavy locomotives and such expensive railway cars as you are now building, and I feel quite that I am not in it; that I ought not to mix with railroad men.

There is one thing I would like to say here that I learned while railroading and which I have found of use to me in traveling about and visiting other countries. At first when I went to visit other

countries I found many things that were different to what I had been accustomed to in this country, and at first I was disposed to criticise them, but I remembered my railroad training, which was: "Don't always criticise things as you find them." Things naturally drift into what is best. It is very fortunate they do; they naturally drift into the best way of doing things, and if you want to investigate it, investigate it with a view of finding out why it is done in that way. So that 1 saved myself many missteps in traveling about and conversing with people of other countries by trying to find out why they were doing things in that way in place of criticising the way they were doing them.

I won't occupy any more of your time. I am very glad to have this opportunity of meeting with you again. (Applause.)

The Secretary: Mr. Chairman, probably all the Chicago members of the Club received a letter from me in regard to the entertainment at the annual meeting next month. In response to that letter some eight or ten of the members met at my office last Friday and have taken the preliminary steps towards having a vaudeville entertainment. There will be another meeting of the members in my office tomorrow afternoon at four o'clock. If there are any of the members here who have any stunts that they can perform, I would like to have them come over to the office to-morrow at that time and help make the program that much better. I assure you we are going to have some vaudeville next month.

The Chairman: That brings us up to the regular papers of the evening, and we will take up the report of the Committee on Proposed Changes in the Rules of Interchange first. Mr. Harvey, the Chairman of that Committee, is out of the city, I believe, and Mr. Thompson will present the report for him. I believe that the usual procedure is for the Secretary to call the rules by number, and if any one has anything to propose you will present it as the Secretary calls the number of the rule. Mr. Thompson, please come forward.

Mr. A. La Mar (Penna. Co.): Mr. Chairman, we have with us to-night several chief joint car inspectors of several of the largest interchange points throughout the country, as well as representative car men, and I move that we extend the same courtesies to those gentlemen as Club members, that they may feel free to discuss or criticise such suggestions as are made before the Club so that we may have the benefit of their opinion.

The Chairman: If there is no objection, that will be the sense of the meeting, and the privilege of the floor will be extended to any visiting railroad men in the room, or those interested.

The Secretary: The first item will be the preface to the rules on page 2. Have any members any suggestions to make as to a change in the preface?

Mr. Thompson: Mr. Chairman, before I proceed to read the

recommended changes, I will state that I was notified by Mr. Harvey late to-day that I would have to present this report. Attached to the papers sent by Mr. Harvey is a letter from Mr. Barrowdale, of the Illinois Central R. R. who has raised some objections to the report of the Committee. He was one of the members of the Committee on revision of the rules but evidently was unable to attend, and on receipt of the report of the Committee has raised some objections. It might be well for Mr. Barrowdale to read his suggestions in conjunction with the rules as recommended changed by the Committee.

First, change third paragraph to read as follows: "Inspection of freight cars for interchange and method of loading will be in accordance with this code of rules, *the requirements for tank cars* and the rules for loading materials, issued by this Association."

The Chairman: What is your pleasure with regard to the recommendation, gentlemen?

Mr. La Mar: Mr. Chairman, may I ask why that recommendation is made?

Mr. Thompson: Well, the Committee thought it more suitable than the present preface.

The Chairman: Would any other members of the Committee who are here come forward, so that possibly they will be able to explain the position of the Committee on some of the recommendations that were made? Mr. Thompson was not aware that he had to handle this until late to-day. Is there any further discussion on this recommendation, gentlemen? If not, a motion to dispose of it will be in order.

A Member: I move that it be adopted.

The motion was seconded.

The motion was carried.

The Secretary: Rule No. 1.

Mr. Thompson: Rule No. 1, change to read as follows: "Each railway company shall give to foreign cars, while on its line, the same care as to oiling, packing, inspection and adjusting brakes, *including tightening of unions and adjusting angle cocks,* that it gives to its own cars."

The Chairman: What is your pleasure with the recommendation, gentlemen?

A Member: I move its adoption.

The motion was seconded.

The Chairman: It might be well to say that the part that is printed in italics, as I understand it, is the change in the present rule. Mr. Barrowdale, I think you have something on that.

Mr. Barrowdale (I. C. R. R.) I would change it in this way: "Each railway company shall give to foreign cars, while on its line, the same care as to oiling, packing, inspection and adjusting brakes, *including tightening of unions and adjusting angle cocks,* that it

gives to its own cars, *without charge.*" Put in the words "without charge."

The Chairman: I presume that really should be an amendment. Do you make that as an amendment?

Mr. Barrowdale: Yes, I do. (Amendment seconded.)

The Chairman: Gentlemen, the action is now on the amendment, which adds to the recommendation of the Committee "without charge." Are you ready for the question?

Mr. La Mar: Mr. Chairman, before the question is put, I believe Rule No. 1 is so framed and understood that you can't charge for oiling, packing, inspecting and adjusting brakes. Now if you tack on one or two items I don't see why you want to add the words "without charge." The rule is plain in what it says, that you give the same attention to foreign cars as to your own cars while on your line, therefore the addition of "no charge" is unnecessary, in my opinion.

Mr. F. C. Schultz (C. B. & Q. R. R.): Mr. Chairman, it has been the practice of railroad companies to charge for the packing of unions and adjusting angle cocks. In order to get away from that, while the Committee put this item in, I am in favor of leaving in the words "without charge," at least for this year.

Mr. Barrowdale: Another thing, Mr. Chairman, my idea was to eliminate Rule 108.

Mr. C. J. Wymer (C. & W. I. R. R.): I am in favor of that recommendation. There is nothing in the rules that says you can't charge, and I have known cases where they even tried to charge for repacking boxes, and I think it is a good thing to have it in there, so as to make it clear.

The Chairman: Any further discussion on this? If not, all in favor of Mr. Barrowdale's amendment will signify it by saying "Aye." Contrary "No." The "Ayes" please stand. The "ayes" have it.

Now the vote will be on the recommendation as amended. All those in favor will signify it by saying "Aye." Contrary "No." Carried.

The Secretary: Rule No. 2.

Mr. Thompson: Change fifth paragraph to read as follows: "Loaded cars offered in interchange must be accepted, except that receiving line may reject cars not loaded in accordance with the rules for loading materials. A. R. A. Car Service Rule No. 15 to apply (see page 88) when transfer or rearrangement of load is necessary. The delivering line will not be charged with cost of transfer if repairs can be made within 24 hours as shown in M. C. B. Rule No. 107."

The Chairman: Will you please just state what the change is there, so that it will be clear?

The Secretary: Mr. Chairman, it leaves out the provision in

regard to tank cars, and it adds the paragraph "The delivering line will not be charged with cost of transfer if repairs can be made within 24 hours as shown in M. C. B. Rule No. 107."

THE CHAIRMAN: What is your pleasure with the recommendation?

A MEMBER: I move its adoption.

MR. LA MAR: I would like to amend that motion and have that read "24 labor hours." I believe that is what the Committee meant, to get material in there and other things, and transfer. It don't mean now what I believe the Committee intended.

The amendment was seconded.

MR. H. W. GARDNER (L. S. & M. S. Ry.): Mr. Chairman, I would like to see that last sentence eliminated.

THE CHAIRMAN: Do you make that as a motion, Mr. Gardner?

MR. GARDNER: Yes, sir.

MR. J. J. O'BRIEN (Ter. R. R. Assn., St. Louis): Mr. Chairman, it appears to me a very unfortunate condition of affairs that the Western Railway Club here, with its great representation, will make certain exceptions in the transaction of business to interfere with the movement of traffic. The tendency throughout the United States to-day is to keep the freight moving forward, not to return it. I see in this proposed rule you still continue to reject, you may reject cars not loaded in accordance with the rules for loading materials. I think you will find that in different parts, both east, south and west, that the larger cities, the large interchange points, are making no exceptions of commodities of that kind, and I believe it would be no more than right for Chicago to act similar to the other cities and have one uniform understanding, that no car be turned back for any cause whatsoever. When you come down to the leaking tank question, which I see you have recommended be eliminated, I think it is a step in the right direction, for the reason that the laws as to explosives take care of it, and it is within everybody's province and power to interpret the law as he deems best and to protect his own interest on inflammables and explosives. I sincerely hope that Chicago will eliminate that restriction, giving them the right of rejection of a loaded car.

THE CHAIRMAN: Any further discussion? If not, are you ready for the question on the amendment? All in favor signify it by saying "Aye." Contrary "No." Carried.

The vote will now be on the recommendation of the Committee as amended. That simply leaves out leaking tank cars and adds Mr. La Mar's amendment of 24 labor hours. All in favor will signify it by saying "Aye." Contrary "No." Carried.

THE SECRETARY: Rule No. 3. No. 4.

THE CHAIRMAN: You understand, gentlemen, if any of you have any individual recommendations to make that the Chair will

be very glad to entertain them, so I hope everybody will feel free to get up if they have anything in mind and give us an expression of what they think.

The Secretary: No. 5. No. 6. No. 7. No. 8. No. 9.

Mr. La Mar: Mr. Chairman, in Rule No. 9 I would move you to change the word "last" to "previous,"—add the word "previous" to "last." The rule reads: "When triple valve or cylinder is cleaned, the initial of road and date of last cleaning must be shown." I move you that the first paragraph under the various captions there be changed to read: "When triple valve or cylinder is cleaned, the initial of road and date of last *previous* cleaning must be shown." The date of last cleaning, as it reads now, is the cleaning that you do, and I believe the rule was intended to refer to the previous last cleaning.

The motion was seconded.

The Chairman: Any discussion? All in favor will signify it by saying "Aye." Contrary "No." Carried.

The Secretary: Rule No. 10. Rule No. 11. No. 12.

Mr. Thompson: Rule No. 12. Make first paragraph read: "The evidence of a joint inspector, or the joint evidence of two inspectors, one *in the employ* of the owner of the car and the other representing a railroad company, that the repairs are not proper, shall be final; the evidence to be signed only after an actual inspection has been made." Add a paragraph as follows: "If repairs are not corrected at time of the inspection, the joint evidence card shall be attached to car as per Rule No. 14."

The Chairman: Gentlemen, you have heard the recommendation of the Committee. What is your pleasure with it?

Mr. Parker: I would like to ask the Committee what the intention was in changing that rule?

Mr. Thompson: The intention was, as I understand it, that one inspector should be in the employ of the owner, and also if wrong repairs were not corrected, that the joint evidence card be filled up, properly signed and attached to the car, to overcome any misunderstanding about the wrong repairs, so that the owner would know who was responsible.

Mr. La Mar: Mr. Chairman, I think that the addition to that rule is distinctly a local one and only interests the car owner and has no place in the rules, and I move you, if I am in order, that the recommendation be not concurred in.

The motion was seconded.

The Chairman: Is that the whole of Rule 12?

Mr. La Mar: Except the last paragraph, about attaching the joint evidence card to the car.

Mr. Thompson: Mr. Chairman, I can't see that there is any harm in letting that thing go through. If we get a foreign car from the Pennsylvania or one of our connections with wrong re-

pairs, and the repairs are of such a nature that it does not require immediate repairs, the car is a rush load and we want to pass it through, perhaps is going to Buffalo, we would make out a joint evidence card showing the parts and attach it to the car, and when the car gets to its destination it is unloaded and taken to the shops nearest to the destination and the repairs are made; it ends right there; the man knows that the wrong repairs have been taken care of, and it means he does not have to make out another joint evidence card or trace it; he knows right where to go to get protection, and I can't see that there is any harm in letting that stand as it is.

Mr. La Mar: Mr. Chairman, that is my whole point: it is a local proposition. You can get joint evidence on that car down in Buffalo where you have a joint car inspector. The repairs are wrong and you show it to him, and in case you find the party that has made the wrong repairs you can counterbill against him. Now that is applicable possibly to the Lake Shore and the Pennsylvania and some few roads throughout the country, but it is not applicable to all the roads. It is a detail we can work out for ourselves, for our own protection, instead of putting a burden on other roads.

Mr. Thompson: I don't see what any one else, any other road, has to do with somebody's else's car, and I believe it will fit the New York Central lines, the Pennsylvania, the C. B. & Q. R. R. or any other road. It simply means that it will do away with some clerical work, and a considerable amount of tracing which we find considerable trouble in getting done.

Mr. Wymer: Mr. Chairman, I think the recommendation is a good one and ought to be retained. The point Mr. La Mar has raised about being able to get joint evidence at Buffalo would be all right in some cases, but quite frequently railroads have repair shops where they do extensive repairs located where they cannot conveniently obtain joint inspection, and have to get a man sometimes at a considerable distance in order to have joint inspection. I can't see where it would do any harm, but I can see where it would save a good deal of unnecessary tracing.

The Chairman: We would like to hear from some of these chief joint inspectors who are here to-day as to what they have to say on some of these rules. Mr. Waughop?

Mr. Chas. Waughop: I hardly think that St. Louis would give joint evidence unless the cars were offered in interchange.

The Chairman: Are you ready for the question? The action will be on Mr. La Mar's amendment now, that you do not concur in the added paragraph. All in favor will signify it by saying "Aye." Contrary "No." It is lost. Now the vote will be on the recommendation of the Committee as a whole. Is there any

discussion? If not, all in favor will signify it by saying "Aye." Contrary "No." Carried.

The Secretary: Rule 13.

Mr. Thompson: Rule 13. Change to read as follows: "The joint evidence card, *showing information contained on* a proper card, upon which a bill has been made, shall be used as authority for rendering bill. *If no bill is rendered, the joint evidence card shall be so marked and* sent to the company against whom the evidence has been presented, and it shall furnish a defect card covering the wrong repairs, if it made them."

The Chairman: What is your pleasure with the recommendation, gentlemen?

Mr. La Mar: Mr. Chairman, I would like to have more light on that before I can vote intelligently. I can't catch the point of the Committee.

Mr. Thompson: Their point is, that you can't make a bill on a repair car at the present time. The rules say so, but it has never been done. It has been objected to by a good many railroads. They want this thing put in plain English so that they will understand it.

Mr. La Mar: Mr. Chairman, it says: "If no bill is rendered, the joint evidence card shall be so marked and sent to the company against whom the evidence has been presented," and so forth. Now if no bill has been made, how do you know against whom the evidence has been presented? If I understand the matter, you get a joint evidence card to-day, and you hold that joint evidence until the road that has made repair bills on you, then you know who made the repairs, and the joint evidence accompanying the repair card is sent to the man making the repairs and is authority to bill against him who made wrong repairs. I certainly don't catch the drift of what is meant by the Committee. I don't believe it means anything.

Mr. Wymer: Mr. Chairman, I believe that recommendation is all right. As the rule now reads, it requires a proper repair card to accompany the joint evidence, and the proposed change eliminates this and requires only the information on the joint evidence card, and I assume that the Committee had in mind the fact that the Interstate Commerce Commission requires that the records be kept on file in the home office for a specified length of time, and if they send this record away it goes out of their possession.

Mr. La Mar: Mr. Chairman, that don't explain to me yet the meaning or intent of the recommendation. You state that the joint evidence card shall be so marked and sent to the company against whom the evidence has been presented, and you haven't got any evidence to present on this joint evidence card unless they make a proper repair card. If they make a proper repair card, you have got the evidence without this addition to

the rule. I am willing to go on with the Committee if they can show me what they mean. I think it is an additional rule that don't mean anything. It is not going to accomplish the purpose the Committee desires.

Mr. Thompson: It meant just what Mr. Wymer said.

Mr. La Mar: All right, but who are you going to put it against unless the party makes out a proper repair card and bill and all, that is what I want to find out. You say here if no bill is rendered. Now if no bill is rendered you can't catch the fellow that made the repairs.

Mr. Wymer: Mr. Chairman, I think it is the practice of railroads when they get a joint evidence card to trace the movements of the car over the railroads and locate where the wrong repairs are made, regardless of whether a bill has been rendered, and call upon them to furnish a defect card if they admit having made the repairs. I don't see anything different in that feature of the rule from what it was before.

Mr. Thompson: I will say, Mr. Chairman, if you send the joint evidence, and you locate the guilty party, he retains the joint evidence in his file, showing his authority to issue the defect card.

A Member: I move that the recommendation be adopted.

The motion was seconded and carried.

The Secretary: Rule 14.

Mr. Thompson: Rule 14. Change third paragraph to read: "Defect, repair, and *joint evidence* cards must be securely attached to the car with four tacks," balance of rule to remain as at present.

A Member: I move its adoption.

The motion was seconded.

The Chairman: Inasmuch as that simply takes care of the change in Rule 13, I believe no further action is necessary.

The Secretary: Have any of the members any suggestions to make on any of the rules up to Rule 24? Rule 24 is the next rule that the Committee recommends be changed. Rule 24.

Mr. Thompson: Change second paragraph to read: "In no case should two wheels be mounted on same axle when the thickness of the two flanges together will exceed the thickness of one normal and one maximum flange, or 2 17-32 inches."

Mr. La Mar: I move its adoption, Mr. Chairman.

The motion was seconded and carried.

The Secretary: Rules 25, 26, 27, 28, 29, 30, 31, 32.

Mr. Schultz: I move you to correct Rule 32 to read as follows: "Damage of any kind to the body of the car due to unfair usage, derailment or accident that requires the making of repairs Defect cards shall not be required for any damage so slight that no repairs are necessary," omitting the words "the receiving line to be the judge."

The motion was seconded.

The Chairman: You have heard the motion, gentlemen. Is there any discussion on this? I am sure some of you will be sorry if you don't have your say now instead of later on.

Mr. Schultz: In explanation of that I will say that it is the present practice of some of the receiving roads to stand strictly upon these words, "the receiving line to be the judge." If those words are omitted it is possible to arbitrate most any kind of a case that may come up, but under the present rule it is so arbitrary in the minds of some of the car inspectors that it is absolutely necessary to be cut out.

The Chairman: Is there any further discussion? If not, all in favor will signify it by saying "Aye." Contrary "No." The ayes have it.

The Secretary: Rule 33.

Mr. Thompson: Rule 33, change to read as follows: "Side and end doors missing from bodies of cars offered for interchange."

Mr. Schultz: I move its adoption.

The motion was seconded.

Mr. La Mar: Mr. Chairman, may I ask a question? As I understand it, then, all material missing from bodies of cars and other things will be entirely omitted, and Rule 33 then will only read: "Side and end doors missing from bodies of cars offered in interchange," will be cardable defects.

Mr. Schultz: Mr. Chairman, I think it is a very broad and good suggestion. In the carding of cars around Chicago to-day, according to our present rules, the car inspectors do and they have a right to card them absolutely for anything that is missing from the body of the car, which they would have a perfect right to do under the rules. The correction in this rule cuts out the cardable defects for missing material from bodies of cars down to the end and side doors. I think those two parts ought to be carded.

The Chairman: Any further discussion?

Mr. Schultz: Mr. Chairman, I don't want this to be misconstrued. This does not mean in any sense that if a car is wrecked, the sides torn out and the parts missing, that is an owner's defect, but it does mean that if a car comes home and the side doors and end doors have been lost in ordinary service they are cardable in interchange.

The Chairman: Is there any further discussion on this? It is a pretty important change in the rules.

Mr. La Mar: Mr. Chairman, I think that that is drawing the line pretty close. I think that will permit railroads to go to work and take everything off of a car, if they see fit, excepting the side and end doors and send it over five or six connections and then

home and the owner shall not get any protection; in other words, the owners would be responsible for all defects. We could as well go a step further and cut out all the combinations, as to do as the Committee proposes at the present time.

Mr. Schultz: Mr. Chairman, if we stop and give this some consideration we will find that the small parts that can be lost from the body of a car outside of the side and end doors don't amount to very much.

The Chairman: Are you ready for the question? All those in favor signify it by saying "Aye." Contrary "No." The ayes have it.

The Secretary: Rule 34. Rule 35.

Mr. Thompson: Rule 35. Add a paragraph reading as follows: "After Sept. 1st, 1914, cars equipped with stem or spindle attachment couplers will not be accepted in interchange."

Mr. La Mar: I move its adoption, Mr. Chairman.

The motion was seconded.

The Chairman: Any discussion? All in favor will signify it by saying "Aye." Contrary "No." Carried.

Mr. Schultz: Mr. Chairman, with permission I would like to go back to Rule 34 and move that it be eliminated.

The motion was seconded.

The Chairman: Gentlemen, you have heard the motion. Any discussion? If not, all in favor will signify it by saying "Aye," contrary "No." Carried.

The Secretary: Rule 36.

Mr. Thompson: Rule 36, omit entirely.

Mr. Schultz: I move its adoption.

The motion was seconded and carried.

The Secretary: Rule 37.

Mr. Thompson: Rules 37 to 42 inclusive. Your Committee wishes to place itself on record as being strongly opposed to the note following Arbitration Case No. 851 and to any changes in the present heading of the above mentioned rules.

We believe that the combinations mentioned should be strictly confined to one end of the car only.

We also strongly urge that second foot note following Rule 42 be changed to read: "It will be assumed that a missing coupler and attachments are *not* damaged."

The Chairman: The only recommendation of the Committee is the last paragraph regarding the foot note. What is your pleasure in regard to that?

A Member: I move its adoption.

The motion was seconded.

Mr. Schultz: Mr. Chairman, I move the Committee explain the reason for the remarks in regard to Arbitration Case No. 851. Arbitration Case 851 was a case where the Committee ruled that

a combination of defects was defects which existed upon one and the same end of the car, but the same decision had a foot note in which the Arbitration Committee suggested that they would recommend to the next convention to have a change so that the combination be effected at both ends of the car, and that is why the Committee should call attention to that. I move its adoption.

The Chairman: Are there any further remarks? That is simply a suggestion, not a change of the rules, so it is not necessary to vote on it. That will simply be brought to the Arbitration Committee's attention in the report of the Club. What is your pleasure with the definite recommendation for the change in the rules made by the Committee?

Mr. Park (Penna. Co.): Mr. Chairman, I would like to offer an amendment to that suggestion, that is, to eliminate Rule 42.

The Chairman: That would be an additional recommendation, Mr. Park. The only recommendation the Committee make is in connection with the missing coupler. You would make that as an additional recommendation, wouldn't you?

Mr. Park: Yes.

The Chairman: I think before acting on Mr. Park's recommendation we will take a vote on the action of the Committee. All in favor will signify it by saying "Aye." Contrary "No." Carried.

Is there a second to Mr. Park's motion?

The motion was seconded.

The Chairman: Are there any remarks on Mr. Park's motion? All in favor will signify it by saying "Aye." Contrary "No."

The motion was carried.

The Secretary: Rule 43.

Mr. La Mar: Mr. Chairman, I don't believe we are through with the combination yet, are we? 37 was taken up. In Rule 33 they want to eliminate all cardable defects. If that is the case, why should not we get into the combinations here and make them stronger than they are at the present time? Now take Rule 37. I believe that rule can be very well—both Rule 37 and 38 can be very well eliminated from the rules, because I don't think that you could damage a draft timber and end sill and a coupler at the same time. As a rule a coupler is the stronger part of the two, and from my observations you don't damage an end sill, a draft timber and a coupler; you do an end sill and a draft timber, but the two in themselves won't form a combination. The same is true with Rule 38. The coupler pocket seems to be the weakest thing, and we damage a whole lot of coupler pockets and draft timbers; it is a combination defect, but it don't denote unfair usage, it is ordinary wear and tear, and in my opinion should be eliminated. When you come down to Rule 39, I feel the same about Rule 39 as I do the other; and Rule 40, I believe that we

should say damage to three longitudinal sills accompanied by damage to end sills; and Rule 41, I believe it ought to be "Damaged longitudinal sills, if necessitating replacement or splicing of more than three sills." If I catch the drift of what the Committee has recommended, they want to cut out all cardable defects, or practically all of the cardable defects. Carding is not the only feature. I believe the items I have just mentioned are damaged on wooden equipment daily, which don't mean by a long ways that the car has been misused. It is ordinary wear and tear, on account of the wooden equipment being among steel cars and used, you might say, as a shock absorbent. I move you, therefore, Mr. Chairman, that Rules 37, 38 and 39 be eliminated, Rule 40 be changed to damage to three longitudinal sills instead of two, and Rule 41 be changed to read in splicing of more than three sills, instead of two sills as it now reads.

Mr. Schultz: Mr. Chairman, I think that is entirely too broad. I don't think it is proper to take a regular car owner's car and expect to hold them responsible for extensive damage. I think that the spirit or feeling of the car owners is that they are perfectly willing to stand for the small parts, but when it comes down to large ones that it is not quite right. But there is one thing in these rules that I would like very much to have cut out, in all the rules that Mr. La Mar mentioned, and that is the word "damaged," and I would like to substitute the word "broken." The word "damaged" may not mean anything, or it may mean a great deal. It is used where there are two broken draft sills, for instance, and if they have any defects at all they are added to the combination. It is the spirit of the rules mentioned that items of damage so slight that they don't require repairs shall not be repaired or carded, but in these rules the damaged part is used in connection with two broken parts in order to form a combination. I therefore move you, Mr. Chairman, that wherever the word "damaged" enters into the combination from Rule 37 to 42, that it be changed to "broken."

Mr. Little: I make a motion now or make an amendment that the M. C. B. rules be suspended in the interchange of cars.

The Chairman: I believe that is a good idea.

Mr. Schultz: Mr. Chairman, I am perfectly sincere in all I am trying to bring about, in changing this word "damaged."

Mr. Little: So am I.

Mr. Schultz: And if you all knew as much about it as I do of how it is being used, I would get a second in a minute.

Mr. La Mar: Mr. Chairman, have I a second to my motion?

The Chairman: No.

Mr. O'Brien: Mr. Chairman, speak of being sincere, I think that Mr. La Mar is rather sincere, and I——

The Chairman: I don't believe so; I looked him right in the eye all the time he was talking.

Mr. O'Brien: He is taking into consideration the new steel car that is built for the ordinary usage of to-day. He is not trying to protect the old, weak, broken-down car,—what are termed buzzards in railroad parlance. His idea is to enlarge the possibilities of breakage or combination, and I believe he is on the right road. You can't form a combination on the new steel car. If you can't, then the intent and purpose should be to increase the liability of the old and weak car.

The Chairman: There was no second to any of the motions. If there is nothing further, we will proceed.

The Secretary: 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53.

Mr. Thompson: 53. Change rule to read as follows: "All freight cars offered in interchange must be equipped with air brakes, M. C. B. Standard 1¼ inch train line, angle cocks, quick action triple valves and pressure retaining valves."

Mr. La Mar: Move its adoption, Mr. Chairman.

The motion was seconded.

The Chairman: Any remarks?

Mr. Thompson: I might say, Mr. Chairman, that is simply combining the three paragraphs in one and the meaning is exactly the same.

The motion was put to the vote and carried.

The Secretary: 54.

Mr. Schultz: Mr. Chairman, I move you to change Rule 54 to make it read as follows: "Damage to any part of the brake apparatus caused by unfair usage, derailment or accident *that requires repairs or renewal.*

The Chairman: Is there a second to Mr. Schultz' motion?

A Member: I second that motion.

The Chairman: Any remarks?

Mr. La Mar: I would like to have Mr. Schultz explain what he wants there.

Mr. Schultz: The idea of adding these words to this rule is that under this rule any damage to the air apparatus, regardless of how slight it is, is carded in interchange, and this change is for the purpose of confining that carding to parts that require repair.

The Chairman: Any further remarks?

The motion was carried.

The Secretary: 55.

Mr. La Mar: Mr. Chairman, would you go back to Rule 52? With your permission I would like to call the members' attention to the last paragraph of Rule 52, which says: "Lag screws must not be used on cars stenciled 'United States Safety Appliances, Standard,' or on cars stenciled 'United States Safety Appli-

ances.' '' Now the reading of that paragraph means that you can't use a lag screw on a car. I don't think that was the intent of the rule. I think the intent of the rule was that lag screws must not be used on safety appliances on cars stenciled ''United States Safety Appliances,'' and so forth. In other words, the way the rule now reads you can't use a lag screw for any purpose whatever. The only restriction we need on the use of lag screws on cars is on safety appliances, as prescribed by the Interstate Commerce Commission. I will move that we change the last paragraph of Rule 52 to read: ''Lag screws must not be used on safety appliances on cars stenciled'' and so forth.

The motion was seconded.

Mr. O'Brien: Mr. Chairman, I believe that wording ought to be changed; it should read ''Lag screws must not be used to secure safety appliances on cars.''

Mr. La Mar: That is acceptable, Mr. Chairman; it conveys the same idea.

Mr. Wymer: Mr. Chairman, this rule undertakes to enumerate a certain number of safety appliances. As a matter of fact, there are a great many that are not enumerated, and it does not seem that it would be practicable to undertake to enumerate them all, and I would like to amend that motion by offering this as a substitute for the rule, which I believe will provide for the entire situation: ''Cars stenciled 'United States Safety Appliances' or 'United States Safety Appliances, Standard,' must have repairs maintained in accordance with the orders of the Interstate Commerce Commission relative to safety appliances.''

The Chairman: Is there a second to the amendment? Hearing no second to the amendment, we will vote on Mr. La Mar's motion.

The motion was carried.

The Secretary: Rules 55, 56.

Mr. Thompson: 56. The Committee recommends that this rule be omitted.

Mr. Schultz: I move its adoption.

The Chairman: It is moved and seconded that the Committee's recommendation omitting Rule 56 be adopted. Any remarks?

Mr. La Mar: I would like to ask why again, Mr. Chairman.

Mr. Thompson: Mr. Chairman, the question came up about so many air hose being burst, and it was found as a general proposition that the hose when they burst were worn out; they were leaky, and if the hose burst en route after it had left the delivering company's yard they were penalized for that hose on the delivering and receiving company's card, which we think was unfair. It is very seldom that you ever find a good hose burst. The hose has usually served its purpose. With the air pipes it is the

same way; it is very often found that pipes are seamy or rust-eaten, and they have to stand responsible.

The Chairman: Any further remarks?

The motion was carried.

The Secretary: Rule 57.

Mr. Schultz: Mr. Chairman, I move that we change in Rule 57 the word "damaged" to "broken."

The motion was seconded.

The Chairman: Any remarks?

Mr. La Mar: Only this, Mr. Chairman, what is the difference between the word "damaged" and "broken?"

Mr. Schultz: A great deal.

Mr. La Mar: I wish I had a Webster's Dictionary here to find out. I can't see the difference. If it is damaged, you want, as I understand it, for your cylinder to be broken, or in fact any part to be broken. If it is damaged, put out of business so as to make it unserviceable, I believe it is the intent of the Arbitration Committee to penalize the delivering line. You take any part that is cracked; it is not broken, it is cracked. However, it is damaged. Cracked is damaged and damaged is broken. I am not broad enough to see the difference between the two words, damaged and broken.

Mr. J. F. DeVoy: I don't know what is the difference between "damaged" and "broken." If I were to run for an office, some legislative office, I would at once get up on the floor somewhere and begin to find fault or to make light—I would try to do something that would put me before the public in the quickest possible time, and that is about what I think is being done here in half of this argument (laughter and applause). There is one thing about it, however, and the facts will bear me out in my eight or nine years' connection with this Club, I found that two per cent. per year of what you recommended was agreed upon after it reached the Arbitration Committee, so that there need be no alarm by any of the members here that this joshing is going to receive any attention or that it will hurt any one. The reason that I asked for the floor was, while I was sitting here I did not have a copy of that rule, but my mind ran back to Billy Barry and the rising generation, when he had sent his son to Harvard Law School, and he says: "Tell me, boy, what is ne*cess*ary?" And the son says: "Why, Father, that is not exactly right, you ought to say *nec*essary." He says: "Boy, I am older than you, and if I say ne*cess*ary then it is ne*cess*ary." The "damaged" and "broken" is about on the same line. Now I don't want to be taking up any more time, but I hope we will vote a little faster. My main object in getting up to talk about this was, I wondered if some of the bright lights who want to change these laws have ever thought of the cost to the railroad companies of making some of these

changes. There is not a man in the country to-day, I believe, but will say that the so-called safety appliance law has cost the railroad companies dollars where it has never done any good. You had better let those rules alone in so far as you are consistently able to do so. I don't see why we are wasting time about "damaged" and "broken," and for that reason I will vote against that.

Mr. Schultz: Mr. Chairman, in order to make it plain to Mr. DeVoy, I want to say that if the men in this room were handling these rules, there would not be any question about it, but when the car inspectors have to interpret these rules it is an entirely different matter. The word "damaged" to them means anything at all, and if you come to my office I will show you defect cards that are used for damaged cars, backed up by these rules, that should not be used. We are trying to make these rules plain so that these men can interpret them properly; that is my idea.

Mr. Park: Mr. Chairman, in consideration of the air-brake pipe in that rule, I believe to confine them to the word "broken" is a dangerous proposition. We have a great many cars knocked off the center and the brake-pipe damaged; it is dented and there is a loss of area that is dangerous; we can't get the air through that pipe quick enough to control our brakes by reason of the loss in area. Therefore I believe it is a dangerous proposition to substitute the word "broken," particularly with the brake pipe.

The Chairman: Any further remarks? All in favor will signify it by saying "Aye;" contrary "No." The noes have it.

The Secretary: Rule 58.

Mr. Thompson: 58. Believing that the present rule has brought about the desired results in getting all cars equipped with 1⅜ inch standard M. C. B. air hose, and taking into consideration the danger and additional work imposed on interchange inspectors in making a thorough inspection of each individual hose to see that label is strictly in accordance with M. C. B. requirements, your committee is of the opinion that the interchange of cars will be greatly facilitated, without jeopardizing any of the good results already obtained, if the rule is changed to lessen somewhat the work of inspectors.

We would therefore recommend and urge that Rule No. 58 be changed to read as follows: "Cars equipped with air brake hose not labeled M. C. B. standard."

The Chairman: You have heard the recommendation. What is your pleasure?

A Member: I move its adoption.

The Chairman: There is no second, so the Committee's recommendation on Rule 58 will not prevail.

The Secretary: Rule 59.

Mr. Thompson: Rule 59. Omit reference to Rule No. 56 in last line.

The Chairman: The omission of 56 carries that with it.

The Secretary: Rule 60, 61, 62, 63, 64.

Mr. Thompson: Rule 64: Change to read as follows: "Material missing from trucks of cars offered in interchange, except journal box lids, nuts, *brake beam safety chains, brake beam guide pins, brake shoes and brake shoe keys.*"

The Chairman: What is your pleasure?

Mr. La Mar: I move its adoption.

The motion was seconded.

The Chairman: Any remarks?

Mr. F. H. Hanson (L. S. & M. S. Ry.): Mr. Chairman, I think we ought to go a little further in that and add "truck springs, column guide and column guide bolts, truck distance pieces and bolts," and if it is in order I will offer that as an amendment.

A Member: I second the motion.

Mr. La Mar: Just one thing further, Mr. Chairman. The rule says: "except journal box lids, nuts," and goes on and enumerates other things; it is the same as the rule reads now. However, various inspectors don't take the rule as intended, and feel that journal box lid nuts is what is referred to, and I would suggest that in the rearrangement of the rule the word "nuts" be placed first, say "except nuts, journal box lids," and go on with the balance of the rule.

The Chairman: Any further remarks? If not, the vote will be on the amendment as offered by Mr. Hanson.

The amendment was carried.

The Chairman: Now the vote on the original recommendation of the Committee as amended.

Carried.

A Member: Mr. Chairman, does that carry the suggestion as to transposing the word "nut?" If it is confusing I can't see any possible objection to changing it.

Mr. Thompson: I think, Mr. Chairman, the suggestion made by Mr. La Mar is all right.

The Chairman: If the Committee will accept that I think it need take no further time.

The Secretary: Have any of the members any suggestion to make on any of the rules between 64 and 91?

A Member: I suggest that we omit in Rule 69 "or if it extends ⅛ inch past the center of flange," making the rule read as follows: "Broken flange, except as in Rule 78, chipped flange, if chip is on throat side of flange, and exceeds 1½ inches in length and ½ inch in width."

In explanation of that I want to say that it has come to my notice

that defect cards are being issued for very small spots upon the flange, just so they extend 1/8 inch past the center.

The motion was seconded.

A vote being taken, the motion was lost.

The Secretary: Any other suggestions up to Rule 91?

Mr. La Mar: I would suggest that we cut out the words "steel-tired" in the third paragraph of Rule 70, making the rule read: "Forged steel wheels may be substituted for cast-steel wheels."

The Chairman: Would you cut that out in the first paragraph too, then?

Mr. La Mar: No, I think it is all right in the first paragraph, because it states that the cars equipped with forged steel or steel-tired wheels and so stenciled, if found with cast-iron or cast-steel wheels, the delivering company is responsible. Now the third paragraph of that rule means if you have a cast-steel wheel under your car, worth we will say nineteen or twenty dollars, that you can substitute a steel-tired wheel, worth about fifty-two or fifty-three dollars. I don't believe that is right. I believe the intent of the rule means a forged steel wheel, which is practically at the same price as a cast steel wheel. Therefore I move that the three words "or steel-tired" be eliminated from the third paragraph of Rule 70.

The motion was seconded and carried.

The Secretary: Any other suggestions between Rules 70 and 91? Rule 91.

Mr. Thompson: Rule 91. Change last sentence of first paragraph on page 44 to read: "The receiving road shall at once issue counter-billing authority to cover the acknowledged error on Form shown on page ..., said form to be attached to the bill." Form attached.

The Chairman: What is your pleasure with the recommendation of the Committee?

Mr. La Mar: Mr. Chairman, I have this written out so I can read it. I don't believe that the M. C. B. Association has authority in connection with this rule. The rule itself definitely states by note as follows: "The following rules of the Association of American Railway Accounting Officers should be observed when rendering or correcting bills," therefore no change can be made in this rule without the approval of the Association of American Railway Accounting Officers.

The Chairman: Is there a motion to dispose of the recommendation of the Committee? If not, it will be the sense that the recommendation will not prevail.

The Secretary: Rules 92, 93, 94, 95, 96, 97, 98.

Mr. Thompson: Rule 98. Show a price for cast-steel wheels and steel-tired wheels.

The Chairman: What is your pleasure with the recommendation? (No action taken.)

The Secretary: Have any of the members any suggestions to make on rules between 98 and 108? Rule 108.

Mr. Thompson: Rule 108. Omit "brake shoes or brake shoe keys," to comply with change in Rule 64.

The Chairman: In as much as we have adopted the change in Rule 64, this will also carry.

The Secretary: Has any one anything to suggest between 108 and 116? Rule 116.

Mr. Thompson: Rule 116. Attention is called to prices allowed for sub-steel under-frames, which seem to be too low to be equitable to car owner.

The Chairman: As this is not a definite recommendation it requires no action. I feel that a motion will now be in order to adopt the recommendations of the Committee as amended as a whole. Will some one make that?

Mr. La Mar: I move, Mr. Chairman, that the recommendations of the Committee as passed be adopted as a whole.

The motion was seconded and carried.

The report of the Committee as amended is as follows:—

REPORT OF COMMITTEE ON PROPOSED CHANGES IN THE RULES OF INTERCHANGE.

To the Members—

The committee appointed to suggest changes in the M. C. B. Rules of Interchange begs leave to report as follows:

Preface. Change Third paragraph to read as follows, "Inspection of freight cars for interchange and method of loading will be in accordance with this code of rules, *the requirements for tank cars* and the rules for loading materials, issued by this Association."

Rule 1. Change to read as follows, "Each railway company shall give to foreign cars, while on its line, the same care as to oiling, packing, inspection and adjusting brakes, *including tightening of unions and adjusting angle cocks,* that it gives to its own cars, without charge."

Rule 2. Change Fifth paragraph to read as follows, "Loaded cars offered in interchange must be accepted, except that receiving line may reject cars not loaded in accordance with the rules for loading materials, A. R. A. Car Service Rule No. 15 to apply (see page 88) when transfer or rearrangement of load is necessary. The delivering line will not be charged with cost of transfer if repairs can be made within 24 labor hours as shown in M. C. B. Rule No. 107."

Rule 12. Make first paragraph read, "The evidence of a joint inspector, or the joint evidence of two inspectors, one *in the employ* of the owner of the car and the other representing a railroad company, that the repairs are not proper shall be final: The evidence to be signed only after an actual inspection has been made."

Add a paragraph as follows: "If repairs are not corrected at time of the inspection, the joint evidence card shall be attached to car as per Rule No. 14."

Rule 13. Change to read as follows, "The joint evidence card, *showing information contained on* a proper repair card, upon which a bill has been made, shall be used as authority for rendering bill. *If no bill is rendered, the joint evidence card shall be so marked and* sent to the company against whom the evidence has been presented, and it shall furnish a defect card covering the wrong repairs, if it made them."

Rule 14. Change third paragraph to read, "Defect, repair and *joint evidence* cards must be securely attached to the car with four tacks," balance of rule to remain as at present.

Rule 24. Change second paragraph to read, "In no case should two wheels be mounted on same axle when the thickness of the two flanges together will exceed the thickness of one normal and one maximum flange, or 2 17-32 inches."

Rule 32. Add after the word "accident" in the first paragraph the words "that require repairs," and strike out of second paragraph the words "the receiving line to be the judge."

Rule 33. Change to read as follows, "Side and end door missing from bodies of cars offered in interchange."

Rule 34. It is recommended that this rule be eliminated.

Rule 35. Add a paragraph reading as follows, "After Sept. 1st, 1914, cars equipped with stem or spindle attachment couplers will not be accepted in interchange."

Rule 36. Omit entirely.

Rules 37 to 42 inclusive. Your committee wishes to place itself on record as being strongly opposed to the note following Arbitration Case No. 851 and to any changes in the present heading of the above mentioned rules.

We believe that the combinations mentioned should be strictly confined to one end of the car only.

We also strongly urge that second foot note following Rule 42 be changed to read, "It will be assumed that a missing coupler and attachments are *not* damaged."

Rule 42. It is suggested that this rule be omitted.

Rule 52. Change last paragraph to read "Lag screws must not be used to secure safety appliances on cars stenciled," etc., etc.

Rule 53. Change rule to read as follows, "All freight cars offered in interchange must be equipped with air brakes, M. C. B. Standard 1¼ inch train line, angle cocks, quick action triple valves and pressure retaining valves."

Rule 54. Add after the word "accident" the words "that require repairs or renewals."

Rule 56. Omit.

Rule 59. Omit reference to Rule No. 56 in last line.

Rule 64. Change to read as follows, "Material missing from trucks of cars offered in interchange, except nuts, journal box lids, *brake beam safety chains, brake beam guide pins, brake shoes and brake shoe keys,"* truck springs, column slides, column slide bolts, truck distance pieces and bolts.

Rule 70. It is recommended that the words "steel tired" in third paragraph be omitted.

Rule 98. Show a price for cast-steel wheels and steel-tired wheels.

Rule 108. Omit "Brake shoes or brake shoe keys," to comply with change in Rule 64.

Rule 116. Attention is called to prices allowed for sub-steel underframes, which seem to be too low to be equitable to car owner.

Respectfully submitted,
H. H. Harvey, *Chairman.*
W. B. Hall.
C. H. Osborn.
Geo. Thompson.
J. M. Barrowdale.
Committee.

The Chairman: That brings us up to the paper of the evening, and though it is getting rather late I hope all who can stay will. The paper is entitled "Water Treatment and Boiler Troubles," by Mr. W. A. Pownall, Water Engineer C. B. & Q. R. R. Mr. Pownall will kindly step forward and read his paper.

WATER TREATMENT AND BOILER TROUBLES.

By Mr. W. A. Pownall.
Water Engineer, C. B. & Q. R .R.

Water treatment in some form is used to a certain extent by most of the railroads that have boiler troubles due to use of impure feed water. Some roads that are equipped with purification plants have the matter well organized and obtain very good results; others that have tried water treatment have not reaped the benefits because it has not been properly followed up. This paper will give some of the causes of and remedies for boiler troubles, the advantages and disadvantages of water treatment, the effect on boilers of various degrees of soda ash treatment, and a method of handling the treatment that will give good results.

Water for Use in Boilers.

When water falls to the earth as rain or snow some of it runs over the surface of the ground into the lakes and streams, and some of it passes into the ground and reappears in springs, wells or in lakes and streams into which it has entered from below. In either case the water dissolves from the surface or from the rocks and earth through which it seeps, a certain amount of mineral matter,

and when pumped it contains two classes of mineral salts, the amounts of which determine its degree of fitness for use in locomotive boilers. These are the incrusting salts and the alkali salts; the sum of the two would represent the total solids dissolved in the water and would be the residue left on evaporation.

Total Dissolved Solids	Incrusting Salts or Total Hardness	Carbonate of Lime and Magnesia (Carbonate Hardness)
		Sulphate of Lime and Magnesia. (Sulphate Hardness)
	Alkali Salts	Sodium Sulphate
		Sodium Chloride
		Sodium Carbonate

Incrusting Salts.

The incrusting salts or total hardness may be divided into the carbonate hardness or carbonates of lime and magnesia and the sulphate hardness or sulphates of lime and magnesia. These are perhaps more commonly known as the "temporary" and the "permanent" hardnesses. When water is boiled at atmospheric pressure the carbonate hardness is precipitated either as a soft mud or a bulky scale on the flues and staybolts, according to the condition of the water in the boiler. The sulphate hardness remains in solution when water is boiled at pressure below 60 lbs., but above this pressure it separates out and forms a hard scale on flues and firebox sheets, the result of which is continual trouble from leaky flues, staybolts and fireboxes due to overheating of the metal.

Alkali Salts.

The difference between the total dissolved solids and the total hardness would represent the "alkali" salts or the sulphates, chlorides and carbonates of sodium. These salts remain in solution after the water has been boiled, and when the total amount in the boiler reaches a certain concentration the boiler begins to foam. Waters high in alkali salts are, on account of their tendency to cause foaming, undesirable for boiler purposes.

In addition to these mineral salts surface waters, especially the streams, at times carry large amounts of suspended matter (mud) and this may cause trouble, if the water in the boiler is in a scale forming condition, by baking on the flues or building in to form a heavier scale. The foaming tendency of the water is also aggravated by this mud and by any decayed animal and vegetable matter that may be found in some waters.

The amount and proportions of these mineral salts found in waters vary considerably in different parts of the country. In the territory covered by the C. B. & Q. R. R. the waters are found as follows:

In Illinois the surface waters all contain more or less sulphate hardness and are low in alkali salts. In Iowa and Missouri the surface waters are lower in sulphate hardness and about the same in alkali as the Illinois waters. Shallow wells in these states furnish, with few exceptions, much harder water than the surface supplies. Some wells of moderate depth in sandstone furnish waters containing free sodium carbonate (soda ash) if they are comparatively near the outcrop of the sandstone, and waters of this type, if not too high in alkali, are desirable as they are non-incrusting. West of the Missouri River in Nebraska well waters as a rule are either low in sulphate hardness or contain free sodium carbonate; these waters, however, increase in the amount of alkali salts as we go westward and have therefore a greater foaming tendency. In Wyoming and South Dakota there are some fairly good quality surface waters, but generally speaking the waters surface and well, are high in both sulphate hardness and alkali salts and it is a case of take what you can get. Some wells in these states furnish waters high in sodium carbonate but with hardly any incrusting matter, and while these are foaming waters they are preferable to the waters that are incrusting as well as foaming.

Causes of Boiler Trouble.

The primary cause of leaky flues, fireboxes and staybolts is unequal expansion and contraction brought about by overheating of the metal due to it being insulated from the water by a layer of scale formed by the precipitation of the lime and magnesia salts in the water. These troubles will be accentuated by any sudden cooling of the metal such as might be caused by holes in the fire, working engine very hard and then suddenly shutting off steam and leaving shut off for some time, cold water from injector falling to bottom of boiler and to washing boilers with cold water. Proper firing will take care of the holes in the fire. There are hilly divisions of such character that it is necessary to work engine very hard up to top of grade and then drift down to bottom, and, unless the flues are kept free from scale, there will be considerable trouble from leaky flues under these conditions. Numerous arrangements are in use for preheating the water entering the boiler, and Figure 1 shows a cheap, simple and effective device for doing this. This is simply a cast iron elbow screwed into the boiler check and pointed upwards so that the water from injector shoots up and is heated as it enters the boiler instead of dropping cold to the

bottom. With this upturned elbow the difference in temperature between water in bottom of boiler and near water level will only be about 10° F., while a full glass of water is being fed and en-

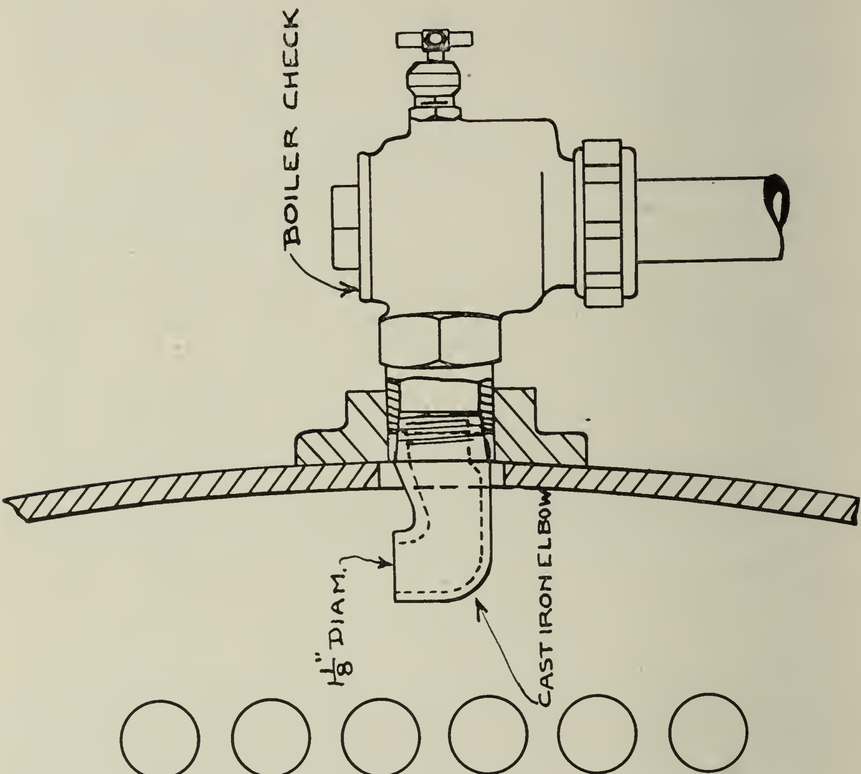


Fig. 1.—Upturned Elbow Extension for 2 inch Boiler Check

gine is standing still; with the ordinary boiler check this difference will run from 80° to 100°.

There are also a number of different kinds of hot water washing plants that supply hot water blown out from boilers for washing out and hot fresh water for filling boilers. An inexpensive plant consists of a sump into which the water and steam from engines to be washed are blown, enough fresh water being let into sump to provide the necessary total for washing and filling. Boilers are thus filled with water that is about half fresh water and half bad water from the boiler, the result being that engine will reach the foaming point and it will be necessary to start blowing off somewhat sooner than if boiler had been filled with fresh water. There should be some kind of a hot water washout plant at all places where any number of engines are washed, and

all engines ought to have some device for heating the water before or as it enters the boiler.

These precautions will avoid sudden cooling, but the important thing is to avoid overheating. If there is no insulating layer of scale on the metal it will never get much more than fifty degrees hotter than the temperature of the water in the boiler, so that even with the cooling effects present, the total temperature variation will not be large enough to cause much trouble. As water in the boiler at 200 lbs. pressure will be at 387° F., the maximum temperature of clean flue ends would be perhaps 440° F., whereas with a heavy coating of scale these would get as hot as 1,000° F., or even hotter. The remedy for most of the trouble then is to prevent overheating by avoiding the scale formation, and this is done by proper chemical treatment of the feed water.

It is not intended to assert that water treatment is the absolute cure for boiler troubles; the boiler work must be done right. For example, one thing that is liable to keep flues leaking is the misuse of the beading tool. If this tool is held incorrectly, as is the tendency in working the lower flues (which are also the ones most liable to leak), these flues, though the leaking is stopped temporarily, will soon start again when engine goes out on road. The bead may be set up against the sheet all right; but the joint in the flue hole ,which to prevent leaking should be good, is gradually made worse and worse until it is nearly impossible to keep flues tight. With proper water treatment, there may be leaky flues due to careless boiler work, but if water treatment is insufficient to prevent flues from scaling they are very liable to leak even with the best of care by the boiler maker·

I think all will agree that where waters that do not form scale are used boiler troubles are rare, and if we haven't such waters the obvious thing to do is to put the waters that we do have in a non-scaling condition.

Treatment.

There are then two evils that are to be counteracted in a boiler water, the tendency to form scale and the tendency to foam. To remove the scaling tendency several different kinds of water softeners are in use. These use slaked lime to precipitate the carbonates of lime and magnesia, and soda ash to treat the sulphate hardness; so that the resultant water as delivered to boilers, if the water softener is designed to allow plenty of time for chemical reaction and settling and is properly looked after, contains only about six parts per 100,000 of total hardness, and is also cleared of most of whatever mud may have been in the original water.

Experience has shown that if waters are treated with enough soda ash to neutralize the sulphate hardness and provide enough excess to have it amount to about 15% of the total dissolved solids in the water from the boiler, all of the scale forming material, both

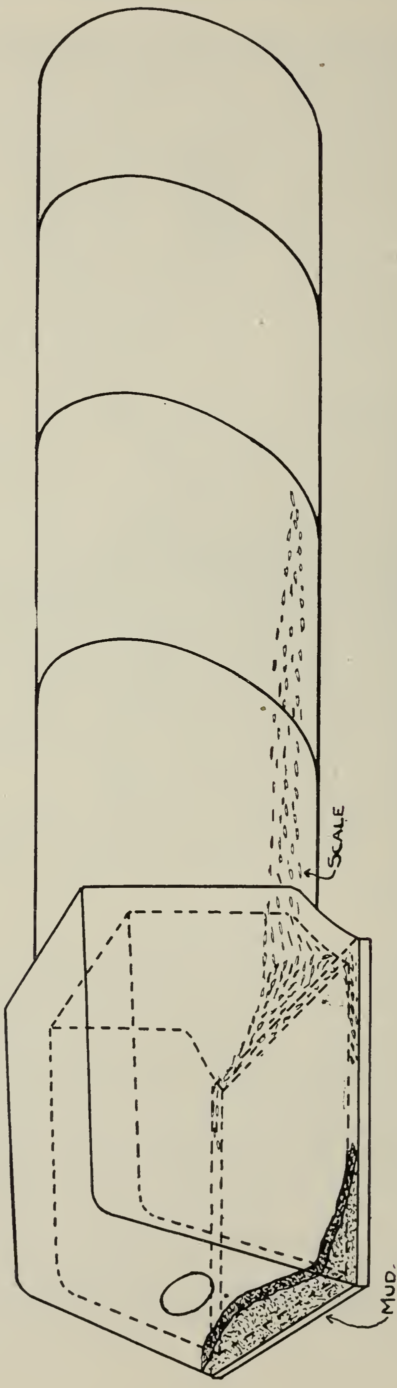


Fig. 2.— Mud and Scale Accumulations in Boiler.

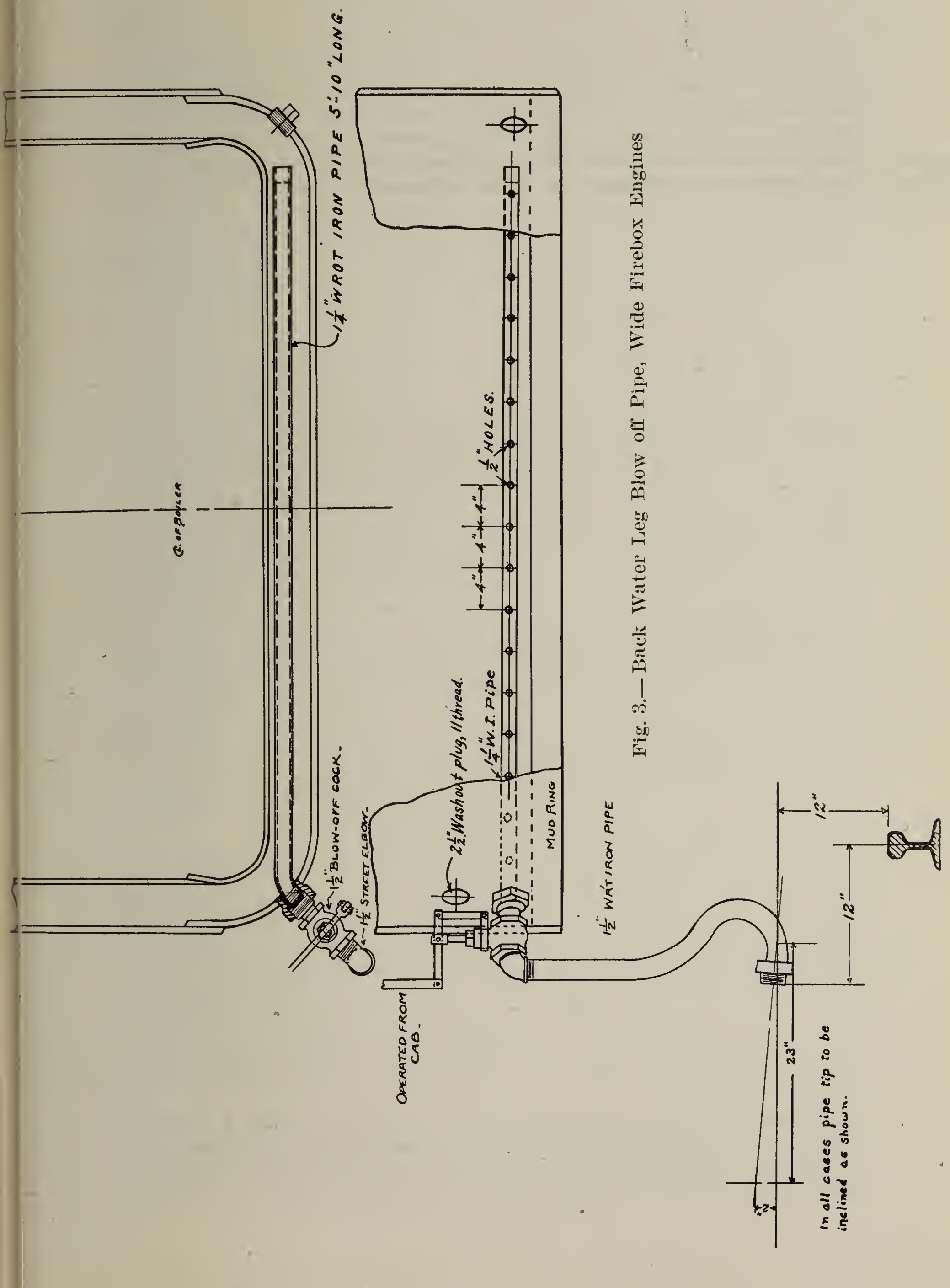


Fig. 3.—Back Water Leg Blow off Pipe, Wide Firebox Engines

carbonates and sulphates, although it goes into the boiler, will be converted into a soft sludge which can be blown out through a properly located blow-off, and there will be no scale formation with its attendant boiler leaking troubles. Soda ash or sodium carbonate is one of the alkali salts that exists in some waters naturally, but it does not exist in the same water with sulphate of lime as the two would react to form sulphate of sodium and carbonate of lime. If then, a water containing sulphate of lime is treated with soda ash this same reaction takes place, perhaps partly in the supply tank but mostly in the boiler, and the carbonate of lime is thrown down as a mud while the sodium sulphate stays in solution, thereby increasing the alkali salts or foaming tendency of the water.

As pointed out before, when the concentration of the alkali salts, which include the natural alkali in the raw water and that added as soda ash, reaches a certain point foaming results. This foaming point varies with different types of boiler and also with the height of water carried in the glass, but in districts where surface supplies carrying more or less suspended matter are used, boilers are usually in a foaming condition when the total dissolved solids in water taken from the boiler are over 200 parts per 100,000. Where only well waters are used this limit will be about 250 parts per 100,000 or even higher. When the foaming point is reached either the boiler is washed, the water changed, or part of the concentrated water is blown out and replaced with fresh water, this being done often enough to always keep the total dissolved solids below the foaming limit of 200 or 250 parts per 100,000 as the case may be.

The mud and carbonates precipitated in the boiler if allowed to accumulate may cause trouble in three ways:

1. The foaming tendency of the water in the boiler increases.
2. Heavier scale will form at times when treatment is light.
3. There is danger from mud-burning.

It is essential, therefore, that engines using treated water be equipped with suitable blow-off arrangement for removing this sludge from the boiler. The circulation of water in the locomotive boiler is along the bottom toward the back water leg where it is least rapid; and all solid particles light enough to be moved by the current are carried back toward that point. When there is scale formation in the boiler the heavier pieces of scale drop out in the belly and in the front of the side legs while the lighter scales and mud are deposited in the back of the side legs and in the back water leg.

If the water has been treated with the proper amount of soda ash there will be practically no scale formation, and the lime and magnesia carbonate sludge will deposit in the back water leg from which it can be removed by means of a perforated pipe extending

across and lying on the back mud ring and connected to a blow-off cock located in the back corner. Such an arrangement is shown in Figure 3.

Where muddy waters are used, a great deal of the mud can be kept out of boilers by equipping the supply tubs with float pipes so that water going to water cranes or down spouts is always drawn from near surface of water in tank. Advantage is thus taken of the natural settling of the mud in the water.

The primary purpose of the blow-off cock where soda ash is used is to replace part of the highly concentrated water in the boiler with fresh water from the tank in order to keep the total dissolved solids in the water below the foaming point. Although the removal of the sludge and suspended matter in the boiler is important it is incidental to keeping the concentration of the dissolved solids down; but the blow-off cock has to be used often enough for the first named reason to keep the boiler always in good condition from the sludge standpoint. Where fully treated water is used and engines are equipped with this blow-off arrangement, engines, if systematically blown off, can be kept in good condition and will run indefinitely without having to wash out boiler. This has been demonstrated by tests and in practice. One division that has treated water and has given this matter considerable attention, averaged for one year, 4,000 miles per washout for all engines on the division.

It is, of course, not advisable to run very far without washing if water is not treated fully and continuously enough to prevent scale accumulation. It is difficult to get out of the habit of washing engines every two or three trips, but where treatment is complete and properly looked after there is no reason for taking the water out of the boiler except through blowing off and at the stated period when the Federal Law says the boiler must be washed.

The mere fact that water has been treated with soda ash does not make it a badly foaming water. The average Illinois water treated does not contain as much alkali and therefore has not as strong a foaming tendency as the Nebraska water untreated, and an engine will reach the foaming point and need blowing off or water changed sooner when it uses the waters higher in alkali whether that alkali is there naturally or whether it was introduced in the form of soda ash.

Amount of Blowing-out Necessary.

The amount of blowing off that has to be done to keep water in boiler below foaming point of 200 or 250 parts per 100,000 depends on the amount of water used, the amount of soda ash used, and the natural alkali in the raw water. Stream waters in Illinois contain perhaps two parts natural alkali and are treated with eight parts soda ash (this corresponds to 2/3 lb. soda ash

per 1,000 gallons), making a total of ten parts alkali salts per 100,000 in the water as fed to the boiler, so that when $\frac{200}{10} = 20$ boilers of water are evaporated water will be at the foaming point, and it is necessary to either change the water completely or do enough blowing to prevent concentration rising over 200; in this case to effect this result it will be necessary to blow away $\frac{10}{200}$ or 5% of the water used. At 15,000 gallons water used per 100 miles, this will mean 750 gallons, and as a 1½" blow-off cock under 200 lbs. pressure will let out about 150 gallons per minute, a total blowing of $\frac{750}{150}$ = five minutes will be necessary to keep boiler from foaming. A minute's blowing on heavy power is about two inches in the glass, five minutes means 10 inches, and this may be done at terminals or on road. Passenger engines ordinarily can be blown enough at terminals to keep them in good condition indefinitely, but freight engines will have to have more or less blowing done on the road as well as at terminals. Where heavy and frequent blowing is necessary operating conditions do not always permit blowing in time and then engine works water. An instance of this sort is where there is a continuous upgrade for 150 miles, water runs high in alkali necessitating heavy blowing, and about the only time freight engines can get ahead enough on water to do the blowing is where they stop at stations. Heavier blowing out has to be done as the total of natural alkali and alkali added as soda ash is higher, and with waters on some divisions the necessary blowing would more than offset the saving in cost of washout and advantage of not holding engine for washout. When this limiting condition is reached it will be cheaper to change water with an occasional washout than to rely entirely on blowing out. There are worse conditions than this, for some waters will run so high in alkali that the use of an anti-foaming compound which raises the foaming point of the water to perhaps 600 parts per 100,000 is necessary for engine to make even one round trip without foaming trouble.

Cost of Blowing-out.

The amount of coal wasted at blow-off cock per one minute of blowing would be 50 lbs., figuring 150 gallons = 1,250 lbs. water blown out per minute and that one pound coal will heat 25 lbs. of water to the temperature of water leaving blow-off cock. With coal at $2.00 per ton and water at 5 cents per 1,000 gallons this would amount to $0.05 per minute for coal and $0.0075 for water, a total of $0.0575.

¼″ Blow-off Cock.

There are several objections against extensive use of the blow-off cock on the road. In passenger service it is impractical to open the blow-off cock on the road, and in freight service it is objectionable on account of heavy drain on boiler in small space of time, whitewashing company property and complaint because of noise and dirtying of property of people residing along the line. Where the country is fairly closely populated and in a number of towns people object so strenuously to the noise and splash of the blow-off cock that it has been necessary to issue orders not to use it at these places, and enginemen often find themselves hard put for an opportunity to blow their boilers. Blow-off boxes so located at intermediate water stations that engine can be blown while taking water relieve the situation materially, but what promises to help solve the problem is the use of a blow-off cock with opening so restricted that instead of a large amount of water being let out of boiler in a short space of time the blowing goes on continuously for an hour or more as the condition demands. An opening ¼″ in diameter will allow about 450 gallons or six inches in the glass to leak away in an hour, and this seems to be a satisfactory size for the continuous blow-off. Where the necessary blowing per 100 miles is 750 gallons, the ¼″ blow-off cock, if kept open $\frac{750}{450} = 1\ 2/3$ hours, would keep the boiler in good condition without having to use main blow-off cock at all. About the only time when it is impractical to use the ¼″ blow-off is when engine is working hard upgrade, and taking all the water one injector will supply; but there is usually plenty of opportunity over the division to use it all that is necessary.

The primary purpose of a blow-off cock is to get rid of the concentrated water in the boiler; the ¼″ blow-off cock does this and actual test has shown that if properly located it also carries away a great deal of the suspended lime sludge. A Pacific type passenger engine with one of these ¼″ cocks in back corner near mud ring and with regular blow-off cock disconnected so that it could not be used made, experimentally, 10,000 miles in fast passenger service without washout or change of water. The average treatment of the water used was ½ lb. soda ash per 1,000 gallons, the average total hardness was about 28 parts per 100,000 (or 16 grains per gallon), yet when boiler was opened for washout it was practically clear of sludge and had only small deposits of old scale in the side water legs. Blow-off cock was kept open about two hours over a 150 mile run. The experience has been that small valves soon cut out, and the best arrangement is the ordinary 1½″ blow-off cock with bushing bored out ¼″ in diameter. Figure 4 shows this arrangement.

The reason for dwelling at such length on the blowing off is that the success of soda ash treatment in a large measure depends upon it. The use of soda ash increases the foaming tendency of

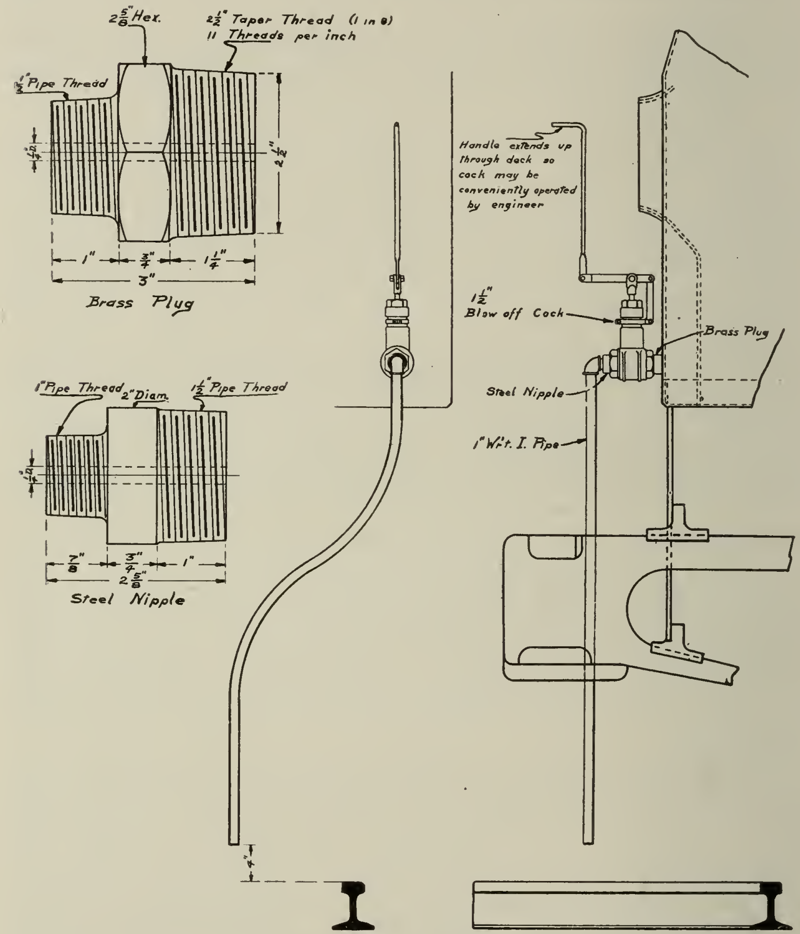


Fig. 4.— ¼ inch Blow-off.

the water, and when the foaming point is reached, if the water is not gotten rid of through the blow-off cock it will depart via the cylinders and valves, causing heavy use of oil, dissatisfaction of the enginemen and various machinery failures.

Procedure in Starting Soda-ash Treatment.

How then shall a certain division be equipped to avoid boiler troubles? We must first get the best available water supplies;

second, provide suitable arrangements for blowing off engines and line up to have engines blown systematically at terminals and on road; third, treat all waters containing sulphate hardness with the necessary amount of soda ash; and fourth, provide sufficient chemical inspection to maintain correct treatment at all times.

Water Supplies.

Chemical analyses of the waters in use for locomotives should be made, and where the sulphate hardness or the alkali salts are high an effort should be made to locate a better supply that can be substituted at a not prohibitive expense. Often water is taken from a well at the bank of a stream and is much harder water than the stream water; it is easy here to discontinue well and pump from the stream. Open dug wells will furnish bad water when bored wells of the same depth will, by excluding surface water, furnish a good water. Bored wells tapping different rock strata furnish waters of different qualities, and the well giving the best quality should be used, casting off any objectionable waters from other strata. Frequently the underground waters at a station may all be bad, and the artificial surface reservoir is a good solution of the problem (as it will usually furnish a fairly good grade of water). The quality of the water from a surface reservoir depends on the character of the ground on the drainage area; if there is much limestone, gypsum or alkali on the drainage area as is often the case between Western Nebraska and the Rocky Mountains and in some cases further east, the water that collects in the reservoir may be very bad. This is contrary to a prevailing belief that rain water being soft, the reservoir water will also be soft. Analyses of a number of samples of run off water from drainage area of proposed reservoir should be made to determine the probable fitness of the water before building the dam, otherwise considerable money may be spent in getting a water supply that will be unusable for boilers.

For every six parts of alkali salts per 100,000 a cent's worth of coal at $2.00 per ton will be wasted at blow-off cock per 1,000 gallons water used, in order to keep water in boiler below foaming point of 200 parts per 100,000. An example of how the difference in cost of a bad water and a better available water can be figured is given below:

	Analyses in Parts per 100,000				Cost in Cents per 1,000 Gallons			
	Total Hardness	Sulphate Hardness	Alkali Salts	Alkali Salts Treated Water	Pounds Soda Ash Per 1,000 Gallons	Soda Ash	Coal Wasted at B. O.	Total
Water in Use.	50	22	12	36	2	2	6	8
Available Supply	28	4	3	9	0.5	0.5	1.5	2

Difference in cost per 1,000 gallons—6 cents.

With the better water there would be a saving in cost of soda ash and coal wasted in blowing off of six cents per 1,000 gallons, much less blowing would be necessary, and there would be less liability to boiler troubles if treatment were neglected or stopped temporarily.

Blowing-off Boilers.

The proper blowing off of engines where water treated with soda ash is used is of utmost importance to avoid foaming failures and excessive use of valve oil, and it is wise to have this lined up pretty well before starting the soda ash. At terminal roundhouses there should be a place for blowing off engine just before it goes onto clinker-pit, and it is also a good plan to provide a similar arrangement on outgoing track to give enginemen opportunity to blow off before leaving. Pipe from blow-off cocks should be located the same on all engines and the end of pipe provided with a threaded nut to enable it to be connected to a steam hose. Then a blow-off box may be used, or where the noise or steam is objectionable engine may be blown through a hose into a sump. Terminal blowing may be done by hostlers or at important terminals there may be one man whose duty is to blow a full glass of water from every incoming engine.

Figure 5 is the open blow-off box and Figure 6 is the sump.

Treatment.

All waters containing sulphate hardness should be treated with enough soda ash to neutralize this sulphate and have treated water show excess of sodium carbonate from one to four parts per 100,000. This excess should be such that waters taken from boilers of road engines will have 15% or more of the total dissolved solids as sodium carbonate (soda ash). The soda ash solution would best be introduced evenly and continuously and should go through separate pipe into the water tank so there will be a chance for chemical reaction before the treated water passes into any pipe lines. With practically all waters, putting the soda ash solution into the discharge pipe from main pump will result in liming up of this pipe, which sooner or later results in closing the pipe to such an extent as to necessitate cleaning it out or laying a new pipe.

Any of the following plans may be used for introducing the soda ash:

1. Steam pumping station with tank within 800 feet.

Connect small plunger pump to main pump and pump soda ash solution from 100 gallon galvanized iron tank through 2″ pipe to supply tank; or, use small duplex steam pump to pump solution from a 300 to 600 gallon solution tank.

2. Gasoline engine pumping station with tank within 800 feet.

Connect small plunger pump direct to main pump or run it by eccentric on extension shaft and pump solution as in (1).

3. Tanks at terminals where city water is used or where pumping station is remote.

(a) Use small duplex steam pump as in (1) and pump solution continuously.

(b) Where compressed air is available force soda ash solution from closed tank continuously to supply tank. Solution pipe runs to top of the supply tank to give constant back pressure and the air to solution tank passes through a reducing valve that maintains a constant pressure 5 lbs. greater than the back pressure. Solution is forced through a perforated metal gasket, the amount of flow required being governed by size of perforation. This is preferable to the pump as it forces the solution evenly and the only attention needed is to mix the solution every 24 hours.

4. Pumping station and supply tank over 800 feet apart or where city water is used.

(a) All water pumped passes through a large water motor which operates a plunger pump to pump the soda ash solution to supply tank. This is in a building close to tank and must be provided with heat in winter.

(b) Figure 7 shows an automatic treating plant with no moving parts to get out of order and one that needs only the attention of charging every 24 hours. It is located in a house near supply tank. Its operation is as follows:

There is an open tank for mixing soda ash, a closed soda ash tank and a closed air reservoir. A perforated metal gasket in main pipe line causes a difference in pressure of about 4 lbs. between the two sides of this gasket. Size of hole in gasket can be calculated from average flow of water. A pipe leads from high pressure side of gasket to air tank. The air pressure created there is transmitted through a small pipe to top of closed soda ash tank and forces solution through a gasket with small hole to supply tank through separate soda ash line. Charging plant consists of emptying air tank of accumulated water, mixing soda ash in open tank and letting it into closed soda ash tank. Flow of solution is regulated by size of hole in gasket in soda ash line so that plant will run 24 hours to one charging.

5. At tanks where little water is used fairly even results can be obtained by suspending the soda ash every 12 or 24 hours in a burlap sack in supply tank. It is difficult to get this done in severe weather and the method is unreliable.

Supervision of Treatment.

A very important feature of treating waters with soda ash alone is to provide enough chemical inspection and supervision to insure keeping all waters treated fully and with as little interruption as possible. If the treatment is a little light on account of neglect of pumpers or insufficient soda ash called for in directions so that the treated waters in general still show some sulphate

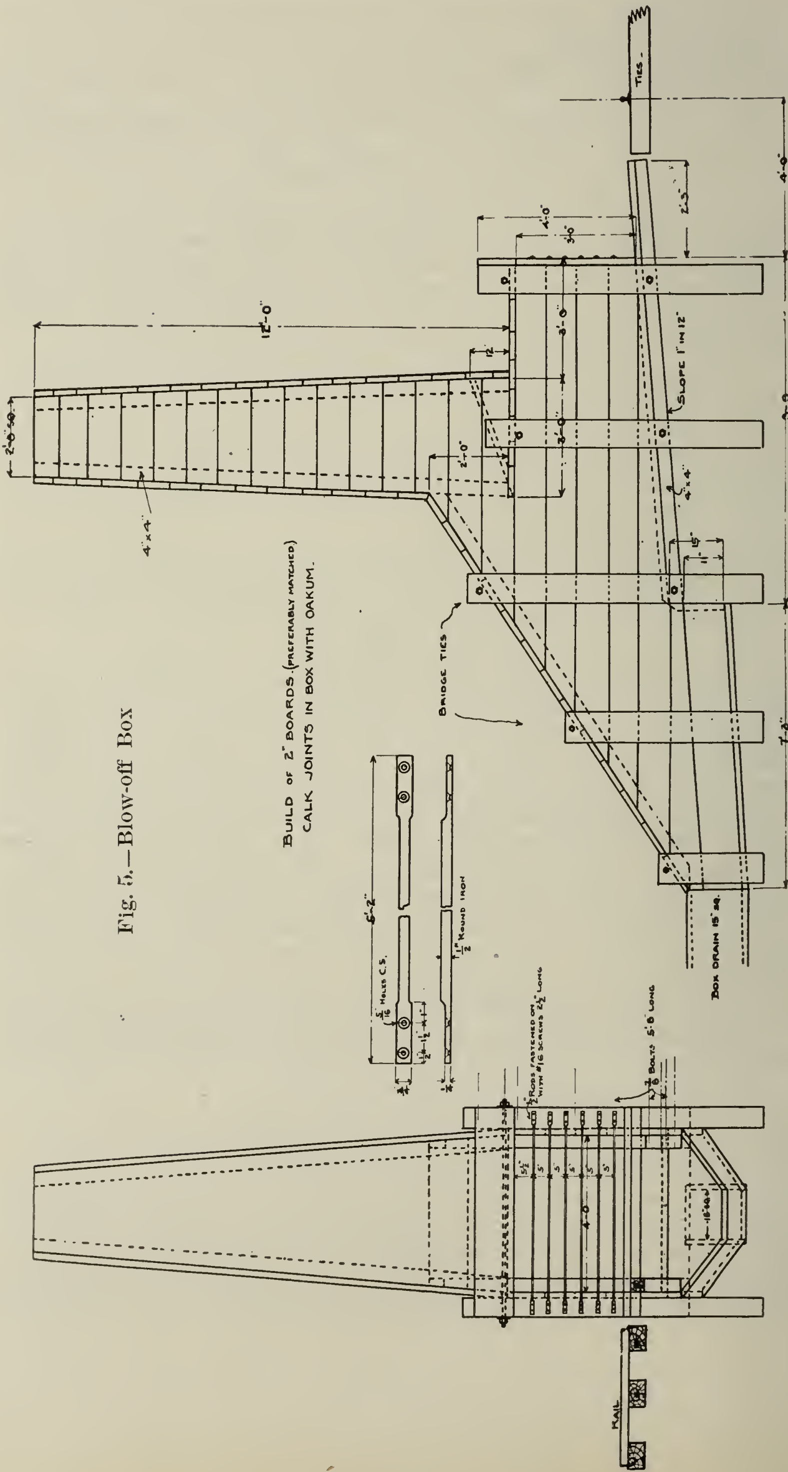


Fig. 5.—Blow-off Box

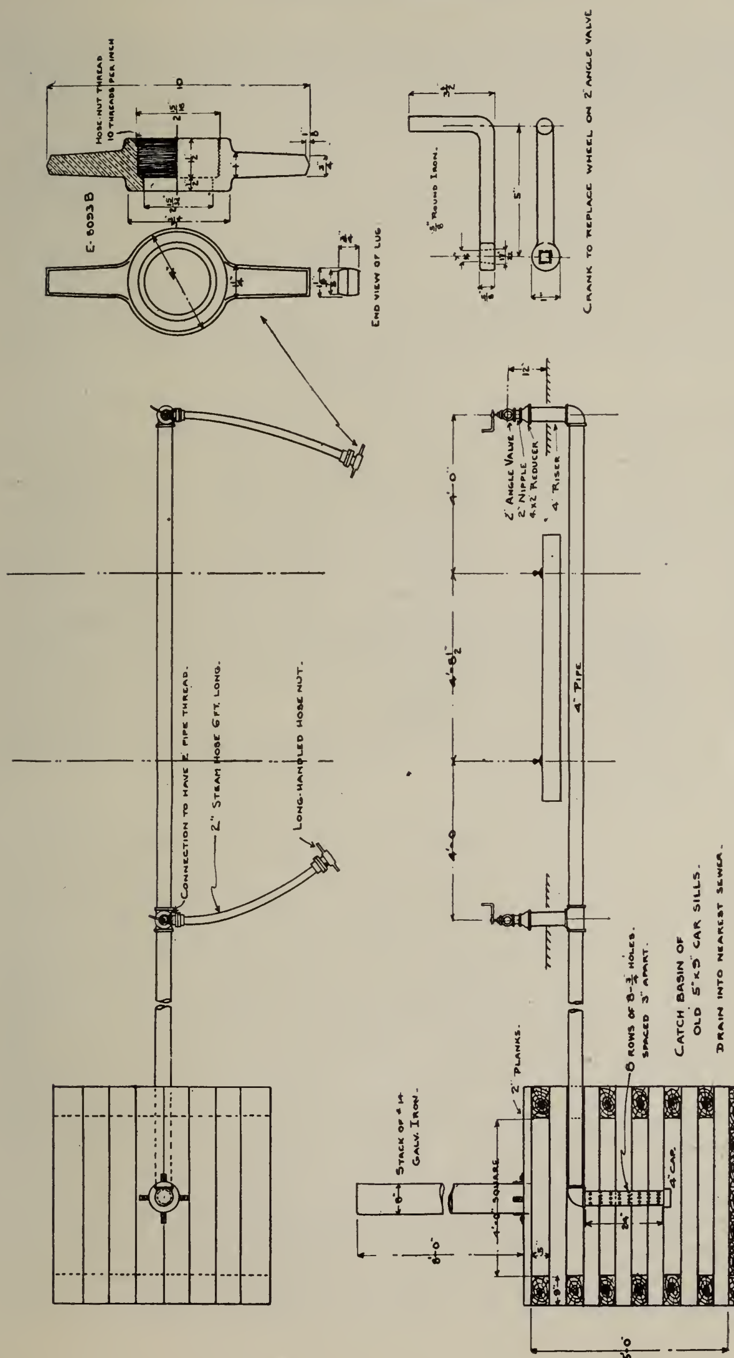


Fig. 6.—Blow-off Arrangement for Engine at Clinker Pit

hardness, then the only benefit is in the small decrease in hardness of the water, due to some precipitation of the lime carbonate in the supply tub. The foaming tendency of the water will have

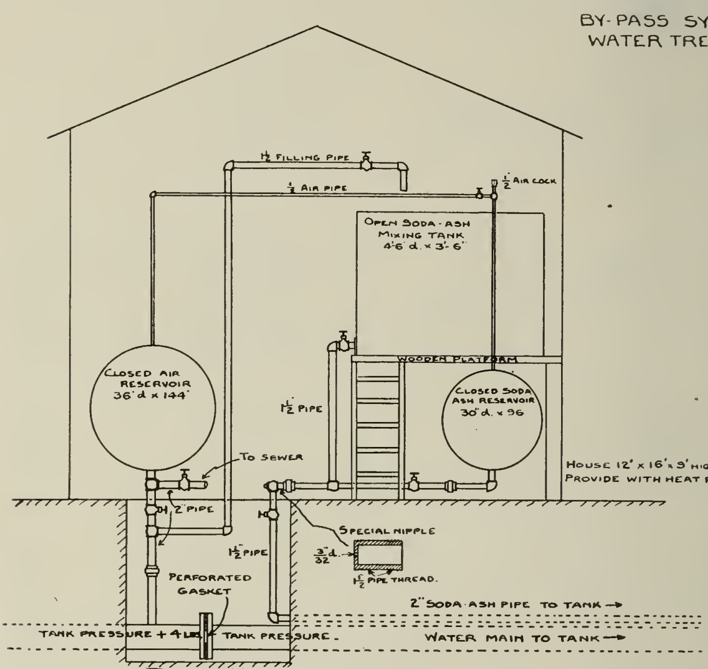


Fig. 7.—By-Pass System of Water Treatment

increased in proportion to the amount of soda ash used, and boiler must be blown off nearly as much as with full treatment; but the hard scale still forms on the flues and causes the leaking troubles that the soda ash is expected to cure. To keep treatment right a road water inspector should make frequent analyses of the raw and treated waters for sulphate hardness or sodium carbonate and should also inspect apparatus for treatment. If this inspection shows treatment wrong he should do what he can on the ground toward adjusting matters, and report to division officials when other steps are necessary to correct pumper or repair apparatus. Men handling the soda ash treatment, whether pumpers, agents or section-men, should be lined up to report at once to superior officer whenever for any reason the soda ash cannot be used properly, and the complaint should be given prompt attention and necessary repairs made. On some divisions the interruption of correct treatment even for a short time causes an epidemic of leaky

boilers, and it is on divisions like this where frequent chemical inspection is important. It is better to keep ahead of the trouble than it is to have trouble and then send a man to locate the cause. On some divisions where the raw waters do not vary much in quality at different times of the year and where there is a dependable class of men handling the soda ash, it will not be necessary to provide so much chemical supervision after treatment has been started and is going satisfactorily, and one water inspector may be able to handle two or three such divisions. On other divisions where the waters vary considerably in quality, where the pumpers, etc., are changing frequently or where slight falling off in treatment is followed quickly by boilers leaking, it pays to keep a water inspector on the division all the time.

The best criterion of the condition of the treatment over any part of the road is gotten from the analyses of waters taken from boilers of road engines. These waters can be collected by the roundhouse force, properly tagged and sent to the laboratory to be analyzed for total dissolved solids and for sodium carbonate. If the total dissolved solids are above the 200 or 250 parts per 100,000 according to the locality, then not enough blowing is being done to keep water in boiler from foaming condition; this will sometimes show that certain engineers are neglecting the blowing and they can be instructed accordingly. If the soda ash is below 15% of the total dissolved solids the treatment is light somewhere, and inspector can make necessary increases in soda ash or perhaps locate some neglect. The following form shows a method of reporting to division officials results of these analyses.

To M. M., Chicago, Ill.:

I have analyzed samples of water collected at Chicago, Ill., taken from boilers and find as follows, results expressed in parts per 100,000:

Eng.	From	Date. 1911.	Total Diss. Solids.	Total Hardness.	Sodium Carbonate	Per cent. Sod. Carb. to Total Dis. Solids	Engr.
1952	Chicago	11-20	242	1.5	36.5	15.0	Scott
1960	"	"	230	1.4	50.6	22.0	Perkins
1910	"	11-19	270	1.6	37.4	13.3	Marshall
1941	"	11-20	202	1.7	30.3	15.0	Dur
2903	"	11-13	234	3.3	32.7	13.9	Bosworth
1952	"	11-12	218	3.0	33.0	15.1	Ray
2802	"	11-13	219	1.8	45.2	20.6	Monks
2848	"	"	193	2.1	41.9	21.7	Brown
2809	"	"	174	2.6	37.4	21.4	Ford
1927	"	11-12	251	1.8	35.2	14.0	Radcliffe
1959	"	11-13	246	2.5	29.5	11.9	Canfield

Remarks.—To prevent scale formation and leaking flues waters should be treated so that there will be over 15 per cent sodium carbonate to total dissolved solids. To prevent foaming enough blowing should be done to keep total solids below 250 parts per 100,000.

Results of Treatment.

The advantages gained by full and systematic treatment of water are as follows:

1. Engine failures due to leaky boilers are reduced to a minimum. On divisions where soda ash treatment has been in use for several years the records show an average mileage per engine failure, due to leaky flues of 513,000 miles. The total yearly mileage on these divisions is about 10,000,000, all waters are treated and most of the engines are heavy power with flues 19 and 21 feet long.
2. Much less boiler work is needed, mileage of flues between shopping is materially increased and the cost of boiler repairs is correspondingly decreased. It is not necessary to shop an engine for flues before the machinery needs it.
3. Mileage between washings of boiler is increased.
4. There is a saving of fuel due to having boiler free from scale. Also a saving of the fuel that heats the water lost from leaking boilers.
5. Engine is not held out of service so much for washing and working on boiler.

The disadvantages are the increased foaming tendency of the treated water and the waste of coal and water in blowing off to overcome this foaming tendency.

The cost of water treatment can be given fairly closely, but it is rather difficult to give in dollars and cents the various savings due to treatment. Some estimates of these costs and savings are given here as so much per engine per year.

Cost of Treatment.

SODA-ASH.

The average amount of soda ash used per engine per year on divisions with moderate treatment will be about 1,700 lbs., which at a cent a pound will be $17.00 per engine per year.

COAL WASTED AT BLOW-OFF COCK.

Every pound of soda ash used per 1,000 gallons of water increases the alkali salts by 12 parts per 100,000 and when 17 lbs. have been used the foaming point of 200 parts is reached and water must be blown out. Therefore for every pound soda ash used 1/17 of 1,000 gallons of water = approximately 500 lbs. of water must be wasted at blow-off cock, and assuming that 1 lb. coal heats 25 lbs. of water to the boiling point at 200 lbs. pressure, it will take 20 lbs. of coal. With coal at $2.00 per ton this will cost two cents per lb. soda ash or $0.02 × 1700 = $34.00 per engine per year.

WATER WASTED AT BLOW-OFF COCK.

As each pound of soda ash used requires blowing out 1/17 of 1,000 gallons of water, 1,700 lbs. would require blowing out 100,000 gallons, which at 5 cents per 1,000 gallons, would be $5.00 per engine per year.

SUPERVISION OF TREATMENT.

The cost of supervision of treatment, including chemical inspection will not amount to over $10.00 per engine per year and should decrease as the efficiency of keeping up treatment increases.

BLOWING-OFF AT CLINKER-PIT.

Extra labor may be employed at some terminals for blowing out engines. This charge and the cost of maintaining blow-off hose at the various clinker-pits will be about $5.00 per engine per year.

Savings.

BOILER REPAIRS.

The saving that can be made in cost of boiler repairs will vary for different localities and depends on the quality of the waters in use on the division to be treated. Where the waters are bad the heavy boiler work necessary means high cost of boiler repairs, and water treatment will result in a much larger saving than on divisions where the waters are of good quality and the expense of boiler work is ordinarily not high. An estimate of the average possible saving in cost of boiler repairs, running and general, will be $250.00 per engine per year. This may be high under some conditions, and low for others.

FUEL SAVING.

There are various estimates as to the amount of fuel saved by clean flues versus flues with scale of different thickness, and tests of locomotive boilers have shown a saving of 10% in clean flues over flues with 1/16″ scale. As boilers using untreated waters start out of shop clean, and even after scaled some of the scale is continually cracking off, the average saving of fuel would probably not be as high as 10%. It seems as though 3% is a conservative estimate and with an average fuel bill of $4,000.00 per engine per year this would amount to $120.00.

WASHING BOILERS.

Where waters are properly treated and engines are equipped with blow-off pipe in back water leg it is practical to run boilers the month allowed by the Federal Law (this is true in general but does not apply to divisions where the natural alkali in the water is so high that a change in water is cheaper than blowing off). If engines receive ordinarily forty washouts per year at a cost of $1.50 per wash or $60.00 total, two thirds of this can be saved or $40.00 per year.

INCREASED SERVICE.

An engine is out of service due to running repairs, general repairs and boiler washing probably 15% of the time or 54 days per year. Some of this is due to boiler work alone and decrease in boiler work ought to cut this down by 10 days. An engine is worth $20.00 a day when power is scarce, but as at times of the

year engines might not be needed though available, I will estimate this saving as five days at $20.00 per day or $100.00 per engine per year.

SUMMARY.

COST PER ENGINE PER YEAR.

Soda ash, 1,700 lbs. at 1 cent per lb.	$17.00
Coal wasted, 17 tons at $2.00 ton	34.00
Water wasted, 100,000 gal. at $0.05 per 1,000	5.00
Supervision of treatment	10.00
Blowing at clinker-pit	5.00
Total cost	$71.00

SAVING PER ENGINE PER YEAR.

Boiler repairs	$250.00
Fuel 3% of $4,000	120.00
Washing boiler	40.00
Ten days' extra service at $10.00 per day	100.00
Total saving	$510.00
Net saving per engine per year	439.00

The above estimate shows a net saving per engine per year of $439.00, and when multiplied by a large number of engines this amounts to a great deal of money. Another saving that is not estimated is the saving in delay to freight and the cost of sending out another engine and crew to haul in a train whose engine has died on account of leaky flues.

In conclusion: it is necessary in order to prevent boiler troubles and insure getting results from water treatment to:

1. Secure best available supplies.
2. Line up enginemen and terminals to blow off boilers systematically and sufficiently to keep ahead of foaming troubles.
3. Give all waters containing sulphate hardness the necessary soda ash treatment and provide enough chemical inspection and general supervision to keep treatment full and continuous.

Soda ash treatment has been condemned and abandoned because of foaming troubles or failure to stop boilers leaking, and I wish to emphasize the importance of blowing off, the remedy for foaming, and of giving the treatment enough attention to keep it full and uninterrupted. If these things are done the treatment will pay large returns and will be well worth while.

THE CHAIRMAN: Gentlemen, the paper is before you for discussion. I am sure the Club owes Mr. Pownall an apology for the lateness at which we begin the discussion, but I hope it won't bar any one who has anything to say on this from speaking, and if not discussed this evening, if there are any opinions to be advanced I

hope that they will be written up and sent to the Secretary and they will be referred to Mr. Pownall and included in the proceedings of the meeting. Mr. Pratt, have you anything to say?

Mr. E. W. Pratt (C. & N. W. Ry.): Mr. President and gentlemen, this is a very valuable paper. The subject is not new, and yet it is never an old subject, and I feel that if we don't say much more we ought to have the author of this paper know that we appreciate it very much, and that he has put down some facts and made us some cuts that are novel. This quarter inch blow-off cock is new to me, and I should be glad to try it out. I might say in this connection that we have had some divisions on the Northwestern road where the water has to be over treated as he describes in the paper here and has caused a good deal of foaming. We have been able to avoid this foaming by frequent blowing off for only a very few seconds. We find that this can often be done even on passenger trains without dirtying the sides of the train, and if the cock is only opened on each side of the engine for a second or two and done quite frequently over the road it lengthens our wash-out periods considerably, just about doubles the number of days that we run per wash-out and keeps the engine free from foaming. It was rather hard to get the engine men to do this until we got hold of blow-off cocks that were more reliable than those that we had. I believe that any kind of a blow-off cock we put on an engine to give the greatest success should be used frequently between terminals.

I notice on page 13 it is suggested that one means of blowing out this concentrated water is to blow out a full glass at the arriving terminal. We have tried that, but I am more afraid of a leaky boiler after you have done it than I am if you blow out a smaller amount at a time. They are apt not to put in a hot fire and blow up steam while filling up the boiler and consequently apt to get the boiler leaking in filling up.

I notice several railroads in building way-side water tanks, are providing a lower portion of the tank, especially the iron tanks, as a mud-catcher. This is not so general but it is a good thing to call the attention of the Engineering department of the railroads to its advantages. We all know that we have always had to keep the mud out of these tanks through the water-spout until very recently, unless we kicked hard enough to get the Bridge and Building Department to get down into supply tanks with rubber boots, and clean them out once in two or three years, but about nine-tenths of all this mud went into the locomotive tank.

The author apparently, if I understand the sketches correctly, would advocate the blowing-off at the rear leg of the boiler rather than the front leg. I don't know that I quite agree with him in that matter, on account of the lowest part of the mud ring being at the front on most of our large power. Hence it would seem as though

the front corner would be better, and it certainly is a little easier to apply the blow-out cock.

On page 4 a cheap arrangement for a hot water sump is suggested, and I might say in that connection that the Northwestern road, and I think several others of our neighbors, has adopted at small points, an old locomotive boiler. The water main from the pump enters in the base of this boiler, and the discharge from the boiler is out of the dome. Into the fire box of this boiler all of the exhaust steam about the round-house is piped from the stationary engines, pumps, air compressors, etc., so that the steam passes through the flues and is condensed and heats this boiler full of water continuously. I think it is very much better than a sump, and it is all pure, clean water.

On this same page 4 the author states that the maximum temperature of clean flue ends would only be perhaps 440 degrees. I am interested to know if there is anything definite about that. It strikes me that is a very low temperature; with the temperature of gases perhaps 2000° and the water at 387°, yet the temperature of the flues is only 53° different from the water.

The Chairman: Is there any one else that wishes to speak? Mr. Fogg?

Mr. J. W. Fogg (B. & O. R. R.): Referring to the last paragraph on page 21, in reference to lining up enginemen and terminals to blow off boilers, in all my experience I have found where we use soda ash it gives good results to blow off the boiler before starting out on a run, because a good deal of sediment accumulates in the leg of the fire box. It is very surprising the amount of sediment that can be blown out of a boiler by doing so before starting out from the round house track. This paper is very valuable, and gives a good deal of food for thought.

The Chairman: Mr. Cota, have you anything?

Mr. A. T. Cota (C. B. & Q. R. R.): Mr. Chairman, all that I could say in regard to the subject would be simply endorsing the paper, in regard to blowing out regularly on arriving at the coal chutes. We are also, on a number of engines, using the quarter-inch blow-off cock. You will find them of material benefit, because they increase the time between the wash-outs of the engine and keep them in very much better condition than we think they otherwise would be.

In regard to Mr. Pratt's suggestion that this frequent blowing off might cause leaky flues, we have no complaint of that, and we blow out as nearly as possible for five minutes on all of the large power, and the boiler is generally filled full, if not already filled, when the engine arrives at the chutes, and we get up a good steam pressure before the blowing off is done. I think it is of great benefit to do that.

Mr. L. F. Wilson (Editor Railway Master Mechanic): Mr.

Chairman, to my knowledge the Burlington has several water treating plants, and I am therefore a little surprised that Mr. Pownall has dwelt so slightly upon this method of securing good water for the locomotives. It is possible that he considers the stationary treating plant a perfect proposition and discussion of it unnecessary.

After a short general description of the water treatment by the plant method in which both carbonates and sulphates of lime and magnesia are removed, he considers only the sodium carbonate or soda ash treatment in the boiler. He shows how, by the addition of certain quantities of sodium carbonate, a reaction is made to take place which decomposes the scale forming sulphates in the water, resulting in mud forming carbonates which go to swell the amount of carbonates already in the water, and in sodium sulphate which stays in solution.

Now by this method we have got rid of most of the scale-forming substance in the water, but we have produced a condition which unless intelligently handled frequently causes more trouble than that we have obviated. The treated water in the boiler gathers more and more soluble sodium sulphate as the engine goes over the division until it reaches a high state of concentration, and foaming takes place. Meanwhile the quantity of sludge which would naturally be precipitated from the water is increased by the carbonates precipitated in the reaction of the treatment. At this point Mr. Pownall seems inconsistent. He states that the only means of getting rid of this concentration is by blowing down. He then proceeds to show how the blow-off may be taken care of by arranging a kind of driveling pipe which will keep down the concentration by drizzling water over the whole division. This method is all right so far as the alkali water is concerned, but he seems to forget the mud in the bottom of the boiler, for part of which he is responsible. My idea of a blow-off has always been a large valve and pipe in the lower part of the water leg where the deposits of mud are heaviest, a sudden blow and a strong blow then being depended upon to remove most of the mud as well as to reduce the concentration of the water. This mud is much more apt to damage the boiler than is the foaming tendency of the treated water and it cannot be gotten rid of by Mr. Pownall's method.

I am told that tests made on the Denver and Rio Grande R. R. recently seemed to prove that it is the insolubles that cause the foaming. If this is true, then the prevention of foaming by reducing the proportion of soluble matter in the water is only accidentally successful, in that you can't blow down a boiler without getting rid of a great deal in insoluble as well as soluble matter. This is a situation well illustrated by a story I heard the other day.

Mrs. Grady accused Mrs. Flaherty of owning a savage dog. She said: "Mrs. Flaherty, your dog bit my boy Micky." Mrs. Grady

was immediately aroused and answered, "Ye're a liar, my dog never bit your boy Micky."

"He did."

"He did not."

"I say he did."

"My dog did not bite your Micky for three reasons: in the first place, he is too old to run fast enough to catch your boy Micky; in the second place, he has no teeth; and in the third place, I have no dog in the first place." (Laughter.)

On page 10 and also on page 19 the cost of blowing is taken up. I became interested in these figures and will admit that I got balled up. As is my pernicious custom, I called in some more experienced friends and one of them produced figures which differed from Mr. Pownall's by 300 per cent. After he had gone, I got busy again and figured it a new way. Mr. Pownall says that one pound of coal heats 25 pounds of water to the boiling point at 200 lbs. pressure. I believe the coal used by the Burlington averages a heat value of about 13,000 B. T. U. The temperature of water at 200 lbs. is 388 degrees. It probably enters the boiler at about 50 degrees. It must then be raised in temperature about 338 degrees, equivalent roughly to 388 B. T. U. If this were all of the problem, then a pound of coal would take care of 38 lbs. of water. But fully half of the emission of the blow-off is steam, and this steam has a latent heat of 383 B. T. U. The heat units in each pound of the water going out of the blow-off is therefore close to 750. Then we have $\frac{13,000}{750} = 17$. Substituting these figures on page 10 we find that our engines are blowing off about 7½ cents in coal per minute instead of 5 cents, and on page 19 it means approximately 30 lbs. of coal for 500 lbs. of water and 3 cents worth of coal per lb. of soda ash, making $51.00 for coal per engine per year. By the way, my figures agree with the table on page 13, but Mr. Pownall's do not. These figures are most conservative when compared to those of others.

With respect to the proposition of having locomotives blown off consistently and regularly while on the road, I do not believe the plan is practicable. The locomotive engineer will not do it. He can scarcely be blamed for not regularly performing a task which is more or less apt to get him into trouble by causing an engine failure. Most engineers will postpone blowing down their boilers until the last minute because they do not wish to take the risk of getting all the water blown out of the boiler through inability to close the blow-off valve. The responsibility is one which you cannot force the engineer to assume in the present day of pooled engines.

I want to ask Mr. Pownall if the use of superheaters does not increase the amount of solids permissible.

Mr. E. S. Woods (Wm. B. Scaife & Sons Co.): Mr. Chairman, this paper is an exceedingly interesting one and brings out some points worthy of thought. It seems, however, to deal almost exclusively with the soda ash treatment rather than with the more comprehensive treating plant method whereby more accurate results can be attained and the accumulation of sludge in boilers avoided.

In handling the subject of incrusting salts some others might have been named, among them silica, oxides of iron and alumina, magnesium chloride, etc. The latter, however, is of greater interest as a corroding agent. Magnesium chloride is disassociated at comparatively low temperatures, liberating hydrochloric acid, which is a bad thing in waters of low alkalinity. However, I don't think the C. B. & Q. R. R. is troubled much with this class of water. There are, however, some waters harmless-looking enough at first glance that produce most serious corrosion due to the presence of a small amount of magnesium chloride; low alkalinity and concentration does the rest. This is only one example of corrosion; many combinations, aside from a free acid water, may occur which will liberate various other acids such as nitric, sulphuric and carbonic. Also, the presence of free oxygen is often a serious menace.

As to foaming, the author has brought out something that I have heard very, very little about, and it is absolutely on the right line. Foaming is not necessarily due to the sodium and potassium salts, as is generally thought. It is due to the sodium and potassium salts together with the condition of suspended matter in the water. I have personally known of boilers that had sodium salts, from 1,500 to 2,000 grains per gallon, that did not foam, but they did not carry any appreciable suspended matter. The author of the paper thinks that from 150 to 200 grains is along about the limit. Of course also in treating these foaming waters barium carbonate can be resorted to, but the cost is somewhat high. Then again the resultant barium sulphate is soluble perhaps to the extent of a grain per gallon, and barium sulphate is somewhat poisonous. Barium carbonate has advantages over the hydrate for softening purposes, but it is too late to go into this.

The method of introduction of water into the boiler shown on page 3 of paper is certainly good; I think nobody would question that. The author speaks of fully treated water. I don't know whether he means water treated by the regular softening plant method or by the introduction of soda ash to the tank. There would be quite a difference in the two treated waters and I would like to know what he had in mind. The question of the supervision of treatment in the soda ash proposition is the key-note to the whole thing, I think. With proper supervision you are going to get more or less favorable results, and without thoroughly proper supervision you are not going to get much but trouble.

As to the "results of treatment" on page 19 of the paper: I had occasion to know about a comparison of fully treated water versus raw water on a large railroad during two six months' winter periods, and the results in favor of the treated water showed that the engine failures were reduced 96 per cent, the over-time paid trainmen 57 per cent and boiler repairs 53 per cent. This checks up reasonably well with the record made on natural soft water district and natural hard water district up in Canada, where it was found that the boiler repairs were decreased 50 per cent and other economies in proportion.

The question of figuring coal wasted in blowing-out water I think is rather a ticklish one; it is a pretty hard thing to figure.

The question of scale as affecting the conductivity of the boiler is one that we do not know very much about. The only thing reliable that I know of is a test that was made in a stationary plant some five or six years ago over two periods of six winter months each. It was an 175 horse power plant with automatic stoking, and the conditions were maintained as nearly the same for the two periods as possible, and there was a difference shown in favor of the clean boiler of 22 per cent coal consumption.

Mr. C. E. Miller (Safety Car Heating & Lighting Company): Mr. Chairman, Mr. Pownall has called attention to the desirability of obtaining a good water supply to begin with. I am under the impression that there are some waters in which the incrusting solids are so high they cannot be treated successfully for locomotive boiler purposes. I would like to ask Mr. Pownall, if he cares to answer the question, what he considers the limit in incrusting solids in grains per gallon which may exist in water to determine whether or not it can be treated successfully. Now the success of any of the water-treating schemes undoubtedly is in a large way due to the supervision that can be given it, and that brings to mind one point.

On railroads that are governed strictly according to Interstate Commerce Commission requirements in their accounting, I believe there is only a small percentage of the expense of maintaining water stations that can be handled by the mechanical department. The rest is required to be handled by the Maintenance of Way Department, and I recall one instance in which the chemist, who was really the man in charge of water-treating, was a member of the mechanical department, and all the pumpers were under the jurisdiction of the Maintenance of Way Department. It happened that there was not very thorough co-operation and the best results of water treating were not obtained on account of the time it took for instructions to reach the pumpers through the Maintenance of Way Department. This is incidental, of course.

Mr. Woods spoke of using barium in treating water. I don't know what results were obtained from it, but I understand that two or three years ago barium hydrate was tried on the Denver & Rio

Grande R. R. I understand that at the present time the price of barium hydrate has been brought down to a point at which it can be used economically.

THE CHAIRMAN: Is there any one else has anything to say?

MR. G. N. PRENTISS (C. M. & St. P. Ry.): I would like to ask Mr. Pownall how large a force they have to maintain to get an efficient supervision of the treatment, and also what data is the foundation for figuring out the 15 per cent. of total solids left in the water that would be carbonate of sodium?

MR. WM. FORSYTH: The success of the soda ash treatment of boiler waters depends on the proper blowing off of boilers so as to prevent the accumulation of sodium sulphate in solution which produces foaming. On account of the objection to blowing off a large volume of water in a short period, the author recommends continuous blowing through a blow-off valve of ordinary size which is bushed or reduced in size by a steel nipple, so that the opening is only ¼ inch in diameter. At ordinary boiler pressure this will discharge 450 gal. of water per hour, and it is proposed to blow off at this rate excepting when the engine is working hard up grade and when steam consumption is equal to the full water supply of one injector. Such a radical change which involves indefinite waste of water and fuel should only be used under the most careful regulation and it is doubtful whether many enginemen will take sufficient interest in their work to prevent undue waste. The expense of the proposed practice should also be investigated by exact measurements of water discharged, of its temperature and of the amount of coal required to heat water to that temperature. The author's figures for the last item are based on too high a rate, 25 lb. of water heated to the temperature at 200 lb. pressure per pound of coal. This estimate is based on a high figure for the heat value of coal and a higher boiler efficiency than is obtained in locomotive practice. For western coals 12,000 B. T. U. is a fair average heat value, and the average efficiency of locomotive boilers is not over 50 per cent.; so that one pound of coal would deliver 6,000 B. T. U. to the water. The number of heat units in water at 200 lb. steam pressure is 387, and $\frac{6{,}000}{387}=15.5$. This estimate shows only 15.5 lb. water heated to the temperature of blow-off when the engine is running in regular service, instead of 25 lb., as assumed by the author. The figures representing the loss due to continuous blowing off are, therefore, too low, and only about 60 per cent. of that here estimated; and if our assumptions are nearly correct, the expense due to this practice as given in the paper should be increased by that amount. Whether continuous blowing off would be economical at such an expense for extra coal consumption, depends on the cost of coal, and there are numerous places in the alkali district where it

would be prohibitive for this reason. The new practice which the paper suggests cannot have general application, but should have expert investigation on every line to determine its actual economy.

The Chairman: If there is no further discussion, I will ask Mr. Pownall to answer such questions as have been asked, thus closing the discussion.

Mr. Pownall: Mr. Pratt spoke of the Northwestern practice of preventing foaming by blowing off frequently on the road for only a few seconds at a time. I have noticed this when riding on the C. & N-W. trains. The total blowing done in this manner between terminals is enough to keep the concentration of the dissolved solids in the boiler water below the foaming point, and I am inclined to believe the total time of blowing will equal our five minutes at terminals. As for this five minutes terminal blow causing leaky boilers, I have seen this done with both injectors on and no leaking trouble resulted. The fact that the flues were free from scale and the feed water was heated as it entered the boiler through the upturned elbow described on page 3, prevents any considerable temperature variations in the flues and consequently no leaking results. If the flues were scaled and cold water were fed direct into boiler, this five minutes blow would be liable to cause leaking trouble as Mr. Pratt suggests.

P. J. Conrath (National Tube Co.): I wish to ask a question, Is there any system in handling your blow-off cock? What I refer to is, is there any rule giving out the way to handle the blow-off cock on the road?

Mr. Pownall: Well, on one division in particular, where after the introduction of the treatment there was a lot of foaming trouble, the Master Mechanic got out a bulletin for the men to blow out a total of at least six minutes between terminals. This stopped most of the foaming.

Mr. Conrath: The point I wanted to make is this, all the blowing off you will do, provided your engineer has the injectors on would not do one particle of good. I have had some wide experience along that line, and if a man opens up the blow-off cock on the road with the injector on, the water is only coming from the tank and going right straight through. I have tried that as an experiment, and I found you are not cleaning out your boiler at all. The fact that they have run 4,000 miles between boiler washings itself is proof that the treating of water is worth while, in fact I know that from past experience, and I don't know of anything that will bring better returns to a railroad company than the treating of water. If you want to eliminate an evil you must get it by the root, and the root of the evil in leaky boilers is in the water to start with, and the treating of the water if properly handled, with proper supervision, will remedy that. There should be an inspector, as Mr. Pownall said in his paper, on every division, and the inspector

should come under the Mechanical Dept. so that he can report to that department and it can keep track and see that the boiler is properly blown off. It is certainly worth while. Mr. Pownall's paper is a very valuable one and I believe has given us something for study. There is one thing he mentions about the overheating of tubes or over-heating of boilers in which I do not agree with him; you can't overheat a piece of iron or steel as long as it has water on it. The trouble with your leaky tubes or the overheating of them comes about in this way; where you have alkali salts in the water the water is very light, and when you treat it, it becomes still lighter, and the water will not adhere to the sheet. To prove this, you take a locomotive boiler and drill a hole in the outside casing, running a nipple through against the inside sheet, with a pet cock on the outside of it; turn this nipple back for two or three turns and when engine is working, you will find you will get steam instead of water, but back a quarter of an inch or more, you probably will get the water. This proves that water does not adhere to hot sheets, thereby causing sheets to heat and bulge. You take a kettle of water that is boiling at say 212 degrees, at the boiling point, and lift it up from the fire, you can hold your hand on the bottom but you can't hold it on top. I just wanted to tell you a little of my experience.

This same thing applies to tubes, especially where spacing of tubes is very close. The body of water being small, and light, when the engine is working hard, it will pull away from the tube sheet, thereby causing tubes to overheat, and water dashing back cooling them off suddenly will make them loose in the flue sheet. This is how tubes and fire box sheets are overheated. As stated before, it is not possible to heat the material as long as water remains against the sheet.

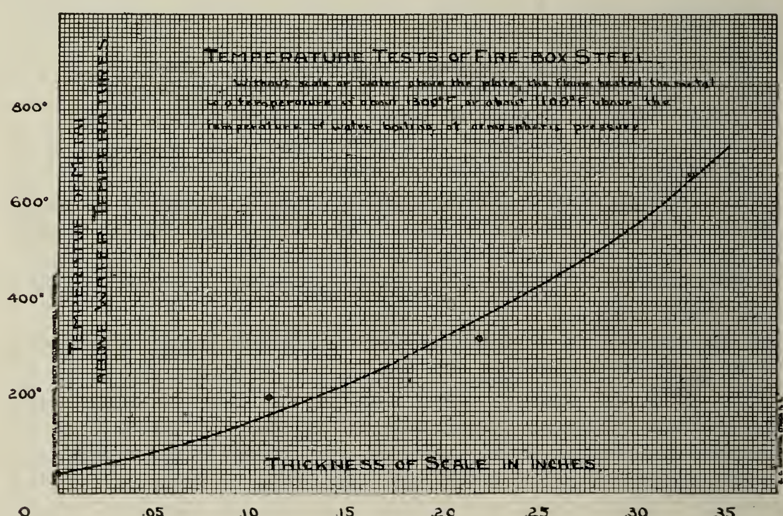
Mr. Pownall: It is probably true that if the boiler is blown off with injector working and feeding water through the ordinary boiler check it will not do much good as the cold incoming water drops to the bottom and would pass out of the blow-off cock, mixed of course to a certain extent with the bad water in the boiler; but with the upturned elbow previously described or with any similar arrangement for heating the water as it enters the boiler the incoming water is well mixed with the water in the boiler and the blowing off is effective.

The question of what is the best location for the blow-off cock was decided by critical examinations of the mud and scale deposits in the boilers of road engines just before washing out, and Fig. 2 represents the deposits as revealed by these examinations. The bulk of the mud deposits first in under the fire-door, and when the blow-off cock in back corner connected to a perforated pipe is used, this space is cleaned for fresh deposit of mud, and the rest of the boiler is kept practically free from mud. Our fire-boxes, however, do not

slope much toward the front, and in boxes with the steep slope some mud might deposit in front.

Mr. Pratt asks if there is anything definite about the statement that the temperature of clean flue ends is only about 440° F. Mr. Wickhorst, our former Engineer of Tests, made some temperature tests to show the temperature of a ½ in. boiler plate with heat applied on one side and with water on the other side separated from the plate by scale of varying thickness and also with no scale on the plate. The temperatures were read by means of a thermo-couple inserted in an eighth-inch hole drilled into the plate. With no scale on the plate the temperature of the metal was only 50° higher than the temperature of the water while with scale ⅓ inch thick the difference was 665° F. In a boiler at 200 lbs. pressure the water temperature is 387° so that the clean metal would have a temperature of about 440° and the metal with scale ⅓ in. thick would be at about 1050° F.

The figure below shows results of this test.



(Figure—A.)

Mr. Fogg thinks it preferable to blow out boiler before starting on a run as it will remove more sediment. Many enginemen prefer to do this as they will be sure they are starting with water in good condition, whereas, the hostler or whoever blows incoming engines may have neglected the blowing, when engines arrived at terminal.

Mr. Wilson has dwelt at considerable length on the evils of our soda-ash treatment and of the practice of letting all of the scale forming material go into the boiler. The Burlington, as he says, has several water treating plants, but several years ago the use of

lime for removing the carbonates was discontinued in these softeners because it was found that good results could be obtained with the use of soda ash alone. Whether or not the carbonates are removed before the water enters the boiler you cannot prevent scale formation unless the sulphate hardness is completely neutralized. This means using soda ash, increasing the concentration of the soluble sodium sulphate in the boiler and finally foaming unless the blow-off cock is used. This method of treating by soda ash alone is not a mere theory. Where we have had it in use for a number of years the failures from leaky boilers have been practically eliminated, engines make good mileage between washings, and the cost of boiler repairs is considerably lower than on untreated divisions.

Mr. Wilson says that I have, in proposing the ¼ in. blow-off, forgotten about the mud. I will call his attention to the last paragraph on page ten and the first on page eleven, in which it states that if properly located this ¼ in. blow off will carry off the sludge. If, as in the test mentioned, an engine ran 10,000 miles between wash-outs with no water let out except through the ¼ in. blow-off and there was practically no mud in the boiler at the end of the test, and no scale on the flues,—what became of the 2,500 pounds of carbonates that went into the boiler during that 10,000 miles?

Now in regard to the question raised as to the foaming being caused by the dissolved or the suspended matter in the water in the boiler. If the suspended matter could be entirely kept out of the boiler the concentration of the dissolved solids could probably be run considerably over the 200 or 250 parts per 100,000 before foaming would occur, but I know of no method of entirely removing the lime carbonates from the water before it enters the boiler. We have waters in Wyoming that carry 50 to 60 parts alkali salts per 100,000 and only four parts of lime carbonates, and these waters cause foaming very shortly unless an anti-foaming compound is used. Using waters furnished by softeners with only a few parts of lime carbonates, the allowable concentration would be somewhat over 250 parts per 100,000 which would mean reduced cost of blowing out. I will be very glad to get authoritative figures on the maximum concentration of dissolved solids before foaming occurs under these conditions. Any test to determine this should be made under severest conditions, i. e., engine must be hauling maximum tonnage and working at the limit, for my figures of 200-250 are for this condition.

Mr. Wilson believes the figure of a pound of coal supplying the heat to 25 pounds of water leaving the blow-off cock is far from correct. This 25 lbs. was calculated by assuming the total heat in a pound of 200 lb. steam to be roughly four times the heat in the pound of water and multiplying four by 6.25, the pounds of water made into steam at 200 lbs. pressure by a pound of coal, averaged from actual road tests on our locomotive boilers. This gives 25. I

will figure this more accurately from figures from Steam Tables. The total heat in a pound of steam at 200 lbs. pressure above a 60° F. temperature of food water is 1199.2—(60-32=1171.2 B. T. U. The total heat in a pound of water under same conditions is 361.4—(60-32)=333.4 B. T. U. and the ratio is $\frac{1171.2}{333.4}$=3.52 instead of 4. The actual water heated per lb. coal would be 3.52×6.25=22 lbs. instead of 25 lbs.

I am sure I cannot agree with Mr. Wilson's method of figuring. In the first place by assuming that we obtain for use from a pound of coal its entire 13,000 B. T. U. he gives our boilers an efficiency of 100%. He says the pound of water that leaves the boiler is not water but is about half steam. This pound of water leaves the lower part of the boiler as water at 200 lbs. pressure, and if it entered the boiler at 60° F. it has absorbed just 333.4 B. T. U. As this water leaving at 200 lbs. pressure drops in pressure on its way through the blow-off pipe to the atmosphere, some of it passes into steams, and it enters the atmosphere as water at 212° F. and some steam at atmospheric pressure; but the total heat in this atmospheric steam and water above 60° F. is 333.4 B. T. U. and it has not, after it left the boiler, by any means obtained any more heat from the boiler. The difference between (361.4+32)=393.4 and 212=181.4 B. T. U. represents the amount of heat used to transform some of the water into steam, and as the latent heat of steam at atmospheric pressure is 970.4 B. T. U. the actual amount of steam that has been generated from the drop in temperature is

$\frac{181.4}{970.4}$=.187 lbs.; the other .813 lbs. is water at 212° F.

Mr. Wilson says my figures do not agree with those in the table on page 13. He does not state where they are wrong, nor can I find any mistake.

It is difficult at first to get consistent blowing off of engines on the road, but the plan is not impracticable. In districts where water is moderately high in alkali and is untreated, an engine-man handles his engine all right because he is accustomed to the situation; in another district where waters are low in natural alkali we increase this alkali by adding soda ash, and although after treatment this water has less foaming tendency than the water on the first district the enginemen have trouble until they adjust themselves to the change in water, by using the blow-off cock.

In the superheater engines the concentration of the dissolved solids in the water would go considerably higher before the foaming would be noticed. The boiler would foam at the same point as an ordinary boiler, but the water going over with the steam would

be reevaporated in the superheater. This would decrease the amount of superheat and cut down the efficiency of the superheater.

Mr. Woods spoke of the action of waters containing magnesium chloride. We do have a lot of serious pitting troubles west of the Missouri River, and I believe this pitting is due to the action of the magnesium salts, either magnesium chloride or other magnesium salts in combination with other chlorides. Water treatment has not been going on there long enough to say whether it will entirely stop the pitting. The paper has dealt mostly with soda ash treatment alone, and by full treatment I mean the use of enough soda ash to neutralize the sulphate hardness of the water and have about 15% of the total dissolved solids in the water in the boiler as sodium carbonate (soda ash).

Answering Mr. Miller's remarks as to the limiting amount of incrusting matter in water to be treated, the supervision of treatment and the use of barium hydrate. In considering a water the total hardness is of less importance than the sulphate hardness, for it is the latter that is responsible for the scale formation and its amount determines the soda ash to be used and consequently the degree of increase in foaming tendency. A water with 15 grains per gallon of sulphate hardness, provided the alkali salts are low, can be treated with soda ash and the increased foaming tendency taken care of with the blow-off cock. Above this point and especially in combination with high alkali salts, the water can be treated successfully, but it will be cheaper to reduce the blowing off by using some compound, changing water in boiler frequently, or both. By doing this waters containing 50 or 60 grains of sulphate hardness per gallon may be treated. If the sulphate hardness is over 15 grains per gallon, it is justifiable to go to considerable expense to obtain a better supply.

Our chemical supervision is under the Engineer of Tests while the pumpers are under the jurisdiction of the Division Superintendent. The Water Inspectors make reports of instances of neglect of pumper or needed repairs to the Division Superintendent who acts on these reports to correct matters. There must, of course, be cooperation in order to get the best results.

The cost of supervision is a small part of the total cost of treatment, and it can ill be dispensed with. It takes careful supervision to keep treatment complete at all times, and if treatment is not kept complete you will not get results.

Treatment with barium hydrate gives very good results, for in removing the sulphate hardness it at the same time removes about the same amount of carbonate hardness, and the treatment does not increase the alkali salts or foaming tendency of the treated water. The incrusting matter is precipitated, on the addition of the barium hydrate as insoluble lime carbonate and barium sulphate, and the treatment should be carried on in a tank that will allow settling of these solids. The price of this chemical has been reduced in late years, but it still costs more than the soda ash treatment.

Mr. Conrath: What force do you employ?

Well, we have had various forces. At one time we had five water inspectors and a water engineer looking after perhaps 80 to 90 stations where water was treated. The chemical supervision is a very important part of the treatment.

Mr. Forsyth misunderstands me in regard to the ¼ in. blow-off cock. It is not recommended to use the ¼ in. blow-off continuously between terminals but only as much as is necessary to keep boiler from foaming, the blowing off is simply spread out for convenience over several hours instead of being done in several minutes. As a rule enginemen do not like to waste coal through the blow-off cock, and there is little likelihood of their using it much more than is necessary.

We have measured the amount of water discharged through the ¼ in. blow-off under 200 lbs. steam pressure and found it to be about 450 gallons per hour. The temperature of the water has not been taken but it can be no higher than 387° F. the temperature of 200 lbs. steam. I have already explained how the 25 lbs. of water per lb. of coal was figured and have recalculated this more exactly. I would, however, change Mr. Forsyth's figures somewhat. He says the average efficiency of locomotive boilers is not over 50%, whereas our road tests show between 60 and 70% efficiency; and he also by saying the number of heat units in a pound of water at 200 lbs. steam pressure is 387, assumes the water enters the boiler at 0° F. which is hardly possible. Making the same assumption that he does of 12,000 B. T. U. per lb. of coal, assuming an average feed water temperature of 60° F. and a boiler efficiency of 62.5%, I would change the figures of

$$\frac{6000}{387} = 15.5 \text{ lbs. to read } \frac{12000 \times .625}{361.4 - (60\text{-}32)} = \frac{7500}{333.4} = 22.5 \text{ lbs.}$$

water heated per lb. of coal. My 25 lbs. is a little high, but on the other hand our average cost of coal is under $2.00 per ton so that the figure of $34.00 for cost of coal wasted in blowing out per engine per year will not be far from right.

Referring to the last part of Mr. Forsyth's remarks in regard to the economy of continuous blowing off. This is a question of the economy of blowing off, whether it be by the 1½″ or the ¼″ blow-off; and, as he states, it should be investigated on every division. Generally speaking, blowing off is cheaper than washing boilers, but the following from the lower part of page nine in my paper sums up this situation:—"Heavier blowing out has to be done as the total of natural alkali and alkali added as soda ash is higher, and with waters on some divisions the necessary blowing would more than offset the saving in cost of washout and advantage of not holding engine for washout. When this limiting

condition is reached it will be cheaper to change water with an occasional washout than to rely entirely on blowing out."

THE CHAIRMAN: If there is nothing further, a motion, to adjourn will be in order.

MR. WILSON: Before adjourning, Mr. Chairman, I move a vote of thanks to Mr. Pownall for the splendid paper on this subject.

The motion was seconded.

THE CHAIRMAN: That will be considered the sense of the meeting.

Adjourned.

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The Annual Meeting of the Western Railway Club was held at the Karpen Building, 900 So. Michigan Avenue, on Tuesday evening, May 21st, 1912. President C. B. Young in the chair. The meeting was called to order at 8:30 P. M. The following members registered:

Allen, E. E.
Allison, W. L.
Anderson, G. W.
Arlein, E. J.
Averill, T. G.
Barnes, C. A.
Banghhan, T. M.
Bender, G. W.
Bilty, C. H.
Blatchford, Carter
Bloom, E. B.
Bradley, W. H.
Brewster, M. B.
Bronson, J. L.
Callahan, J. P.
Carr, B. S.
Chisholm, J. E.
Christenson, H. F.
McClain, H. O.
Clark, J. W.
Connolly, W. L.
Constant, E. J.
DeRemer, W. L.
Duffey, C. J.
Ebert, W. F.
Ellis, G. H.
Fenn, F. B.
Fitzmorris, Jas.
Flavin, J. T.
Fogg, J. W.
Fowler, W. E., Jr.
Fugate, F. L.
Gardiner, H. W.
Geer, R. B.
Gill, Jno.
Gillespie, A. W.
Gilmore, F. M.
Hall, W. B.
Hansen, F. H.
Harris, D. T.
Heingarten, C. D.
Hennig, O. P.
Horne, J. W.
Hummel, J. H.
Hurley, J. B.
Jones, M. T.
Lawrence, W. J.
Lickey, T. G.
Lovell, C. P.
Lundehn, Otto
McAlpine, A. R.
Manchester, A. E.
Maxwell, H. F.
Mellon, Geo.
Mourne, J. E.
Monroe, M. S.
Moody, W. O.
Morehead, L. B.
Motherwell, J. W.
Nettels, E. H.
North, L. A.
Ortmann, I. M.
Parker, P.
Peck, C. S.
Phillips, L. R.
Pratt, E. W.
Pollock, G. L.
Post, G. A. Jr
Price, R. C.
Rees, Jos. A.
Royal, Geo.
Ryan, M. F.
Schoonmaker, A.
Scofield, W. C.
Senger, J. W.
Sheffer, A. M.
Shoenberger, E. R.
Sinkler, Jos.
Sisson, V. E.
Smith, Robt.
Smith, W. R.
Squire, W. C.
State, R. E.
Struble, C. H.
Ussher, G. C.
Thomson, Geo.
Thomson, Jno.

Tinker, J. H.
Tolan, C. Jr.
Toohey, M.
Towsley, C. A.
Van Dorn, W. T.
Walbank, R. T.
Walker, E. H.
Wallace, W. G.
Walters, E.
Watkins, H. W.
Wendt, P. W.
Whitsel, N. B.
Willcoxson, W. G.
Winchell, J. I.
Wolfe, Chas.
Wright, Wm.
Wymer, C. J.
Youngs, F. A.
Zealand, T. H.

The President: The meeting will please come to order. The first order of business is approval of the minutes of the last meeting. Those have been printed and sent out; you all have your copies, and if there are no objections, they will stand approved.

Next is the report of the Secretary.

The Secretary: Mr. President, I have the usual membership statement.

Membership, April, 1912	1,430
New members approved by Board of Directors	16
Total	1,446

NEW MEMBERS.

Name	Occupation	Address	Proposed by
Edward Carter, Loco. Engr. Grand Trunk Ry., Chicago			B. H. Jeffries
Frank L. Johnson, Pressed Steel Car Co., Chicago			P. Parke
C. J. Holland, Amer. Steel Foundries, Chicago			D. T. Harris
Marshall E. Keig, Harry Vissering & Co., Chicago			J. W. Taylor
Wm. J. Eddy, Insp. Tools & Machy. C. R. I. & P. Ry., Chicago			H. La Rue
E. Walters, Am. Steel Foundries, Chicago			F. H. Hanson
Geo. A. Post, Jr., Standard Coupler Co., Chicago			C. B. Young
G. J. Duffey, M. M. L. E. & W. R. R., Lima, Ohio			T. H. Goodnow
Thomas Lehon, Lehon Roofing Co., Chicago			D. T. Harris
Jas. H. Slawson, Natl. Mall. Castings Co., Chicago			F. R. Angell
Edward O'Malley, V. P. & G. M. O'Malley Beare Valve Co., Chicago			F. M. Gilmore
Frank Ryan, Pittsburg Spring & Steel Co., Chicago			J. W. Taylor
A G. Bancroft, Joliet Ry. Supply Co., Chicago			C. B. Young
Chas. W. Dake, Consulting Engineer, Chicago			J. Will Johnson
J. E. Buckingham, Supt. M. & R. E. Wells Fargo Exp. Co., New York			J. W. Taylor
H. P. Bailey, Pyle National Electric Headlight Co., Chicago			J. Will Johnson

The President: These new members have been considered by the Board and approved, and will be entered on our membership list.

Next is the annual report of the Secretary-Treasurer.

The Secretary then read the following report:

To the President and Board of Directors:

I attach hereto my report as Secretary and Treasurer of the Western Railway Club for the year ending May, 1912.

The attendance during the year has been up to the average; the interest manifested in the papers for discussion indicates that the topics have been live ones.

The financial condition of the club owing to the difficulty in securing advertisements during the year does not make as good a showing as in former years, but the balance is on the right side of the ledger.

I trust that during the coming year a larger number of our members will interest themselves in the advertising columns of the Club proceedings, as it is from that source that the main revenue of the club is derived.

Our ranks have been depleted by the Grim Messenger of Death, seven members having died during the year.

I attach hereto list of additions to the Western Railway Club library. I might add that the Library has not been made use of to the extent it should be and it has been quite a burden to the club finances. The expenses of the Library are high in proportion to the use made of it, and your Board of Directors feel that effort should be made to dispose of this library unless its use would justify the expense connected with its maintenance.

The following is a statement of changes made in the membership during the year:

Membership, April, 1911		1,495
Dropped for various reasons	81	
Resigned	66	
Dead	7	154
		1,341
New members during the year ending April, 1912		89
Total membership		1,430

The following is a list of those taken from membership for various reasons:

DROPPED

G. L. Dolan	Jno. Sheppard	E. J. Jackson
O. A. Fisher	F. C. Shafer	W. R. Hungerford
E. H. Landers	H. H. Schroyer	R. E. Gribbens
W. C. Patrick	C. Stanley Sale	Geo. P. Goodrich
H. A. Simms	Anthony Saddler	W. H. Garrett
Frank Slater	Frank Ryan	D. E. Gardner
A. O. Smith	M. F. Russell	W. F. Fries
Jno. Throll	W. H. Rourk	Henry Fries
H. E. Warner	W. H. Riley	W. F. Fantom
W. P. Waugh	Geo. H. Rice	W. H. Distin, Jr.
W. J. Courtney	A. B. Quimby	Geo. L. Dillman
W. P. Raidler	Jno. Pfeiffer	H. E. Dickerman
R. B. Kadish	F. G. Phegley	J. B. Cunningham
G. B. Coffin	J. R. Peoples	H. E. Correll
A. J. Stott	Carl Penner	G. T. Cooke
E. C. Washburn	F. J. O'Rourke	R. C. Alsdorf
R. W. Wilkie	Martin Norell	A. J. Chapman
O. W. Young	F. T. Mullen	T. T. Cavanaugh
R. S. Wickersham	W. B. Moulton	C. H. Carman
Saml. Wheeler	W. B. Moulton	F. R. Brown
W. B. Water	E. C. Miller	J. G. Broman
B. F. Tucker	M. B. McNulty	W. H. Bradley
E. S. Toothe	Geo. B. Maltby	J. J. Barry
C. H. Tierney	Edgar Lewis	W. J. Ball
E. W. Tetlow	F. A. Lawler	J. A. Baldwin
E. D. Taylor	J. S. Lanby	C. F. Balch
B. F. Sipp	J. A. Jackson	Olaf Anderson

RESIGNATIONS.

F. C. Batchelder
W. J. Lynch
H. W. Peters
G. G. Fisher
F. W. Marquis
Jos. Mulheisen
J. O. Neikirk
J. H. Stubbs
C. V. Weston
E. R. Webb
Wm. Lalor
W. D. Wood
W. S. Taussig
J. T. Carroll
H. A. Bowman
C. B. Conger
A. Bridge
F. E. Place
W. D. Smith
A. W. Anderson
S. W. Whiting
J. P. Murphy
H. B. Hatch
F. R. Pechin
C. R. Naylor
C. H. Johnson
E. E. Kretchmer
G. A. Beland
J. S. Ford
T. F. Dreyfus
S. W. Prime
A. E. Hooven
T. P. Convey
H. L. Holman
W. P. Evans
J. J. Adams
E. A. Drake
A. A. Bowman
F. L. Sylvester
W. J. Haney
R. J. Schlacks
L. A. Hopkins
J. L. Benedict
A. Bement
C. H. Quereau
S. F. Denny
T. F. Brady
E. B. Halsey
M. L. Newhall
Saml. Higgins
N. F. Harriman
Geo. W. Moses
A. J. Walsh
H. S. Bryan
W. J. McAndrew
O. L. Dickinson
W. G. Boulton
C. W. Kinnear
R. J. Schlacks
L. L. Dixon
G. W. Scott
E. F. Gould
P. D. Schenck
M. A. Garrett
J. N. Hatch
R. G. Coburn

DEAD

W. F. Buck
J. F. Mann
M. E. Ward
W. W. Johnson
M. J. Horan
Jos. McDonald
C. E. Olhausen

NEW MEMBERS.

Name Occupation Address Proposed by

The following is a list of new members during the year:
T. H. Hummel, Asst. Treas., Templeton, Kenly Co., Chicago..W. B. Templeton
M. H. Reasoner, Chemist, I. C. R. R., Chicago, Ill..............J. W. Taylor
V. E. Sisson, M. E., Imperial Appliance Co., Chicago, Ill........B. M. Carr
R. E. Frame, M. E., American Car & Fdy Co., Chicago, Ill........B. M. Carr
A. S. Sternberg, G. C. K. I., Wabash R. R., Springfield, Ill......C. J. Wymer
W. D. Barton, American Car & Fdy Co., Chicago, Ill............F. P. Collier
W. J. Stoll, C. J. I., Toledo, Ohio.........................T. H. Goodnow
Jos. O'Neil, O'Neil Lumber Co., St. Louis, Mo............J. M. McCarthy
T .C. Carry, Railway Supplies, Chicago, Ill..................Andrew Spiers
W. A. Summerhays, G. S. K., I. C. R. R., Chicago, Ill..........J. S. Sheafe
M. K. Kimberly, T. H. Symington Co., Chicago, Ill..........C. R. Naylor
C. G. Tarkington, Westinghouse Elec. & Mfg. Co., Chicago....G. P. Nichols
H. K. Trask, American Loco. Co., Chicago, Ill..............A. M. Scheffer
C. E. Miller, Safety Car Htg. & Ltg. Co., Chicago, Ill......J. G. VanWinkle
J. H. Rodger, Safety Car Htg. & Ltg. Co., Chicago, Ill......J. G. VanWinkle
L. B. Morehead, Draftsman, I. C. R. R., Chicago, Ill..........H. O. McClain
A. T. Crocker, Draftsman, C. & N. W. Ry., Chicago, Ill........L. P. Michael
F. A. Harper, G. F., Western Steel Car & Fdy. Co., Chicago......P. Parker
W. E. Worth, G. S., Ill. Tunnel Co., Chicago, Ill..............C. A. Barnes
Otto Lundehn, C. D., Swift & Co., Chicago, Ill................M. F. Covert
W. A. Bennett, Griffin Wheel Co., Chicago, Ill................J. W. Taylor
J. B. Jordan, Crane Co., Chicago, Ill.........................F. D. Fenn
B. C. Hooper, Railway Matls. Co., Chicago, Ill................H. H. Gilbert
R. C. Black, Spec. Apprentice, C. & N. W. Ry., Chicago, Ill....W. T. Gale

Michael Schwarz, M. G. R., Alcohol Utilities Co., New York City ....W. E. Sharp
C. F. Dodson, Baldwin Loco. Wks., Chicago, Ill..................Chas. Riddell
W. H. Bentley, Standard Steel Wks., Chicago, Ill..............Chas. Riddell
J. E. Buckingham, Standard Steel Wks., Chicago, Ill..........Chas. Riddell
H. N. Scott, Griffin Wheel Co., Chicago, Ill.....................C. F. Kopf
I. M. Ortman, Griffin Wheel Co., Chicago, Ill....................C. F. Kopf
E. E. Chapman, A. E. T., A. T. & S. F. Ry., Topeka, Kas........R. W. Hunt
M. S. Plumley, Lind Air Products Co., E. Chicago, Ind.............M. Doran
J. R. Jackson, Asst. in Test Dept., A. T. & S. F. Ry., Topeka, Kas ....R. W. Hunt
M. P. Frutchey, Mgr. Ingersoll-Rand Co., Chicago, Ill........R. W. Rusterhol
M. F. Cox, M. E., L. & N. R. R., Louisville, Ky............R. W. Rusterhol
A. L. McNeill, A. P. A., C. & A. Ry., Chicago, Ill..............W. B. Hall
R. P. Noble, Westinghouse A. B. Co., Chicago, Ill............C. J. Olmstead
G. W. Bender, Burton W. Mudge & Co., Chicago, Ill........Herbert Green
C. R. Branson, M. P. Inspr., Penna Lines, Ft. Wayne, Ind......J. R. Conick
E. B. DeVilbiss, M. P. Inspr., Penna Lines, Ft. Wayne, Ind......J. R. Conick
Wm. Langlands, R. H. F., C. & N. W. Ry., Chicago, Ill........A. J. Filkins
W. A. Stockbridge, Penna. Railway Co., Ft. Wayne, Ind........J. R. Conick
A. W. Gillespie, Secy. Chgo. Railway & Mill Supply Co., Chgo..C. A. Nathan
W M. Baxter, G. M. Inspr., I. C. R. R., Chicago, Ill..........H. O. McClain
M. J. Woodhull, Mgr. O. F. Jordan & Co., Chicago, Ill........S. T. Rowley
W. J. Devine, G. A. B. Inspr., C. & N. W. Ry., Chicago, Ill......L. M. Carlton
C. A. Shoemaker, Mgr. Carborundum Co., Chicago, Ill..........J. W. Taylor
A. L. Rockwell, Chemist, I. C. R. R., Chicago. Ill..............J. S. Sheafe
E. Pratt, New York Air Brake Co., Chicago, Ill................C. P. Lovell
C. W. Cross, Supt. Apprentices, N. Y. C. Lines, Chicago, Ill..J. W. Taylor
W. F. Ebert, Crandall Packing Co., Chicago, Ill..............J. W. Taylor
G. W. H. Thomas, American Steel Foundries, Chicago, Ill......J. R. Stuart
P. C. Jacobs, H. W. Johns-Manville Co., Chicago, Ill..........J. A. Meaden
O. M. Carry, S. A., American Car & Fdy. Co., Chicago, Ill....Andrew Spiers
J. S. Miller, West. Mgr., U. S. Metal & Mfg. Co., Chicago, Ill..Andrew Spiers
J. M. Lorenz, Central Electric Co., Chicago, Ill................J. W. Taylor
R. M. Baker, Central Electric Co., Chicago, Ill................J. W. Taylor
J. H. Nash, S. S., I. C. R. R., Chicago, Ill......................J. S. Sheafe
G. A. Graber, Kerite Ins. Wire & Cable Co., Chicago, Ill......B. L. Winchell
R. M. Osterman, Loco. Superheater Co., Chicago, Ill..........G. L. Bourne
F. W. Marquis, Eng. Dept., University of Ill., Urbana, Ill....E. C. Schmidt
Robt. Earl, M. C. B., Kingan Co., Indianapolis, Ind............D. T. Harris
Chas. Mallory, Supt., Kingan Car Lines, Indianapolis, Ind......D. T. Harris
W. E. Shamp, G. C. I., C. B. & Q. Ry., Aurora, Ill............H. H. Harvey
W. G. Nichols, V. P., Edgar Allen Steel Co., Chicago Heights, Ill..H. F. Hall
R. E. S. Geer, Westinghouse Elec. & Mfg Co., Chicago, Ill..........W. Doud
G. A. Morley, Draftsman, M. C. R. R., Ypsilanti, Mich....C. W. Millspaugh
F. E. Tenkonohy, Draftsman, M. C. R. R., W. Detroit, Mich..C. W. Millspaugh
P. C. Hacquebart, Draftsman, M. C. R. R., W. Detroit, Mich.C. W. Millspaugh
C LeFeral, Loco. Engr., Belt Ry. Co., Chicago, Ill............C. A. Barnes
C. A. Delaney, West Reor: American Loco. Co., Chicago, Ill....J. W. Taylor
C. W. Rhodes, Buena Vista, Va............................J. W. Taylor
W. N. Ogden, M. B. Suydam Co.. Pittsburgh, Pa............H. R. Swearer
C. B. Peck, Draftsman. A. T. & S. F. Ry., Topeka, Kas..........C. B. Hill
W. J. Lawrence, C. R. I. & P. Ry., Blue Island, Ill..............R. E. State
J. P. Landreth, Mgr., Garlock Pkg. Co., Chicago, Ill............F. D. Feine
J. A. Reese, V. P., Empire Iron & Steel Co., Chicago, Ill......D. T. Harris
W. D. Wright. S. A., Railway Steel Spring Co., Chicago, Ill....N. C. Naylor
F. L. Barber, Standard Car Truck Co., Chicago, Ill............L. W. Barber
B. A. Broom, M. I., C. B. & Q. Ry., Chicago, Ill...............J. G. Crawford
Wm. Ormsby, M. S. F., I. C. R. R., Chicago, Ill................Jos. Miller

F. M. Egolf, Repr., Curtain Supply Co., Chicago, Ill..........S. W. Midgley
E. T. Millar, Lino Paint Co., Chicago, Ill......................W. D. Hall
Paul A. Bevan, American Vanadium Co., Pittsburg, Pa....L. M. Lammede
O. S. Beyer, Jr., Mechl. Dept., C. R. I. & P. Ry., Chicago, Ill........H. LaRue
C. A. Liddle, American Car & Fdy. Co., Chicago, Ill..............A. Spiers
T. T. O'Brien, Term. R. R. Ass'n. of St. Louis, St. Louis, Mo..T. H. Goodnow
E. B. Heitman, M. M., Chgo. Union Transfer Ry., Clearing, Ill..J. A. Lozier
B. A. Clements, Worth Bros Co., Chicago, Ill..................T. L. Dodd

RECEIPTS

Balance on hand, May, 1911	$ 666.51
Receipts from all sources	4884.50
Total receipts	$5551.01

EXPENSES

Binding annual proceedings		$ 540.64	
Cost of advertisements		608.20	
Library:			
Salary Librarian	$ 240.00		
Insurance	7.80		
Rent	381.00		
Expenses	5.04	633.84	
Office expenses		136.94	
Postage		482.25	
Printing		2140.03	
Reporting proceedings		164.70	
Salary Secretary		300.00	
Zinc cuts		7.89	
Premium on Bond-Secretary		10.00	
Expressage		199.90	
Total expenses			$ 5,224.39
Balance on hand			326.62

The bills receivable are as follows:

From advertising	$ 1,730.28
From annual dues—$6.00	444.00
From annual dues—$4.00	548.00
From annual dues—$2.00	340.00
Total	$ 3,062.28

The assets of the Club in so far as available funds are concerned can be estimated about as follows:

From advertising	$ 1,730.28
From payment of dues, 25% off	999.00
Unappropriated balance	326.62
Total available assets	$ 3,055.90

Western Railway Club Library.

REPORT FOR YEAR ENDING MAY 1, 1912.

At this date the library contains 1614 volumes. The number of accessions during the year 1911-12 is as follows:

American Railway Master Mechanics proceedings, 44th annual convention, 1911, Chicago, Ill.

American Society of Freight Agents, 24th annual report, 1911-12. St. Louis.

American Society of Mechanical Engineers, Year book corrected to Jan. 1, 1912. New York, 1912.

American Iron & Steel Association, Annual statistical report, 1910. Philadelphia.

American Railway Bridge & Building Association, Annual report 20th. Elgin, Ill., 1910.

Answers 3d year, Mechanical and Air Brake examinations, Chicago & Northwestern Ry. National Ry. Pub. Co. Chicago. Gift of F. S. Mordaunt.

Atchison, Topeka & Santa Fe. Ry., special and latest third year examination. Questions and answers. Ry. Pub. Co., Chicago. Gift of F. S. Mordaunt.

Cleveland Engineering Society. Annual Register and Constitution corrected to July 1, 1911. Cleveland, O.

Encyclopædia of Railroading? 6 vols. Chicago (1901) Gift of F. S. Mordaunt.

Industrial Alcohol, its Manufacture and Uses. New York, 1907. Gift of H. S. Park.

Institution of Civil Engineers, proceedings 1910-11, Vol. 183, pt. 2, London, 1911.

Institution of Civil Engineers proceedings, 1910-11, Vol. 184, pt. 2, London, 1911.

Institution of Civil Engineers, proceedings 1910-11, Vol. 186, pt. 4, London, 1911.

Institution of Civil Engineers, proceedings 1910-11, Vol. 187, pt. 1, London, 1912.

Institution of Civil Engineers proceedings Name index Vols. 119, 170 (1894-95, 1906-1907), London, 1910.

Institution of Mechl. Engineers, proceedings 1908, pts. 3-4. Westminster, S. W.

Institution of Mechanical Engineers, proceedings 1909, pts. 1-2. Westminster, S. W.

Institution of Mechanical Engineers, proceedings 1910, pts. 3-4. Westminster, S. W.

Institution of Mechanical Engineers and the American Society of Mechanical Engineers, proceedings Birmingham meeting, July, 1910, Westminster, S. W.

International Railroad Master Blacksmith's Association, proceedings 19th annual convention, 1911. Toledo, O.

Junior Institution of Engineers, journal and record of transactions 1910-11, Vol. 21. London, 1911.

Library of Congress report of the librarian, 1911. Washington Gov't. printing office, 1912.

Locomotive and Carriage Sup'ts. Committee, affiliated with the Indian Railway Conference Association. Proceedings during 1911 and at the Calcutta meeting Jan. 22d, 1912 and following days. Bombay.

Master Car & Locomotive Painters Association of the United States and Canada. Proceedings 38th annual convention, St. Paul, Minn., 1907. Reading, Mass., 1907.

Master Car Builders' Association proceedings 45th annual convention 1911. Chicago, Ill.

Mechanical Examinations, questions and answers, First, Second and Third Year. Chicago, 1910. Gift of F. S. Mordaunt.

Railway Storekeepers Association, second annual meeting Chicago, Ill., 1905. Erie, Pa., 1905.

Register of Porto Rico for 1910. Prepared and compiled under the direction of Hon. M. D. Carrel, Acting Secretary of Porto Rico, Oct. 1910. San Juan, Porto Rico, 1911.

Traveling Engineers Association, proceedings 17th annual convention, Denver, Colo., Sept. 7-10, 1909. Buffalo, N. Y.

U. S. Dept. of the Interior, Bureau of Mines. Resume of Producer Gas investigation, Oct. 1, 1904; June 30, 1910, by R. H. Fernold and C. D. Smith. Washington Government printing office, 1911.

U. S. Dept. of the Interior, Bureau of Mines. Steaming Tests of Coals and related investigations, Sept. 1904, Dec. 31, 1908. By L. P. Breckenridge, H. Kreisinger and W. L. Ray. Washington Govt. printing office, 1912.

Westinghouse Air Brake Instruction charts. Gift of F. S. Mordaunt.

The President: There are three things in that report that I should like to call your attention to. First, we are not quite as well off as we were a year ago. We still have money in the treasury, but we have not as much as we had last year. Our income comes from two sources, members, and every member present of this Club can help getting new members. We have 1,430 members, and if every man will do his work, we will have 2,860 members a year from now. But the membership fees do not cover the expenses of the Club; the principal source of income is from the advertising. Our railroad members are not in a position to give us very much advertising; the advertising necessarily comes from the supply men, and I hope that the members of this Club who are in the supply fraternity will use their efforts to put advertising in our monthly proceedings. I believe it pays; it is value received, and if the members present will work to get additional members for next year and additional advertising for next year, a year from now we will have more money in the treasury than we have at the present time, and I hope you will all bear this in mind.

This being the annual meeting, the next on the program is election of officers for the coming year. We will need a couple of collecting tellers, and I will appoint Mr. Wallbank and Mr. Sheath as tellers to collect the ballots. We will need three counting tellers, and I will appoint Mr. Squire, Mr. Cota and Mr. Tawse. Will you kindly prepare your ballot for President?

The Secretary: Mr. President, the members will find voting slips on the chairs.

Mr. J. F. De Voy (C. M. & St. P. R. R.): Mr. President, before we start to vote, will you be kind enough to have the Secretary read off the officers who are in office at the present time?

The Secretary read the provision of the constitution in regard to election, and then read the names of the present officers.

The Secretary: Mr. President, while the members are preparing their ballots, I see in the audience several of our past presidents. I would like to suggest that they be brought up here so the members can see what they look like. (Applause.)

The President: The past presidents have a unanimous invitation to come up and take seats on the platform.

The Secretary: Mr. Hetzler, Mr. De Voy and Mr. Forsyth.

Mr. De Voy: Mr. President, Mr. Forsyth says he will not come. If you will appoint a committee of supply men, I will help take him there. (Laughter.)

The President: Have you all voted? If so, I will declare the ballots closed.

The counting tellers reported result of ballot for president as follows: Total number of votes cast, 143. T. H. Goodnow, 129; H. La Rue, 7; C. B. Young, 5; Scattering, 2.

Mr. E. W. Pratt (C. & N. W. Ry.): I move that the Secretary be authorized to cast the unanimous ballot of this Club for Mr. Goodnow as president. (Seconded.)

The President: It has been moved and seconded that the Secretary cast the unanimous ballot of this Club for Mr. T. H. Goodnow as President. All in favor signify by saying "aye." Contrary "no."

Motion carried unanimously.

The Secretary: Mr. President, I have done so with pleasure.

The President: I declare Mr. Goodnow elected president for the ensuing year. Please prepare your informal ballot for first vice president.

Mr. Goodnow: I should like to nominate for first vice president, Mr. La Rue. (Seconded.)

The ballot for first vice president resulted as follows: Total number of votes cast, 164. Henry La Rue, 160; E. W. Pratt, 3; W. B. Hall, 1.

Mr. Pratt: I move that the Secretary cast the unanimous ballot of the Club for Mr. La Rue for first vice president.

The President: It has been moved and seconded that the Secretary cast the unanimous ballot of the Club for Henry La Rue as first vice president. All in favor please say "aye." Contrary, "no." It is carried.

The Secretary: Mr. President, I have done so.

The President: Mr. La Rue has been duly elected first vice president for the ensuing year. Have all members voted on the informal ballot for second vice president? If so, I declare the ballot closed.

The result of ballot for second vice president was as follows: Total number of votes cast, 157; W. B. Hall, 93; S. T. Park, 44; C. T. Olmstead, 13; W. O. Moody, 7.

Mr. Hall receiving the majority of votes cast, it was moved by Mr. Goodnow that the Secretary be instructed to cast the ballot of the Club for Mr. Hall for second vice president.

The President: It has been moved and seconded that the Secretary cast the ballot of the Club for Mr. Hall for second vice president. All in favor signify by saying "aye." Contrary, "no." Carried.

The Secretary: Mr. President, I have done so, with pleasure.

The President: Mr. Hall is declared elected second vice president.

The President: Please prepare your informal ballot for Treasurer. The present treasurer is Mr. Taylor.

The report of the tellers on ballot for treasurer was as follows: Total number of votes cast, 136; J. W. Taylor, 133; scattering, 3.

It was moved that the President be instructed to cast the ballot for Mr. Taylor.

The President: It has been moved and seconded that the President be instructed to cast the ballot for Mr. Taylor for treasurer. All in favor signify by saying "aye." Contrary, "no."

Motion carried unanimously.

The President: With pleasure I cast the unanimous ballot of this Club for Mr. Taylor for Treasurer. (Applause.)

The President: Will you please prepare your ballots for the three directors. While the ballots for treasurer are being counted, we will ask that some one make the motion that those receiving the three highest votes be elected directors; this will save some time. Vote for three members. Mr. Hall having been elected second vice president, can no longer be elected as director. S. T. Park and C. T. Olmstead have been on the board this last year, and are, I suppose, candidates for re-election, and at least one new member must be elected.

Mr. Goodnow: I should like to nominate for the new member

Motion to close nominations was not seconded, and the following additional nominations were made: Mr. George Pollock, of of the Board Mr. E. W. Pratt. (Seconded.)

A Member: Move that nominations be closed.

the C. & E. I.; Mr. A. J. Cota, C. B. & Q.; Mr. George Thompson, of the Lake Shore.

The President: While the tellers are counting the ballot for directors, we will proceed to elect the Library Trustees. These are not officers of the Club and we do not have to ballot on them. The present trustees are Mr. Seley, Prof. Goss and F. W. Sargent, and I would be glad to entertain a motion that these be elected by acclamation.

Mr. La Rue: Mr. President, I make such a motion. Motion seconded.

The President: It has been moved and seconded that Messrs. Seley, Goss and Sargent be elected trustees of the library. Those in favor say "aye." Contrary, "no."

Motion carried unanimously.

The President: It is so declared.

The counting tellers reported the result of ballot on directors as follows: E. W. Pratt, 67; S. T. Park, 42; C. T. Olmstead, 38; scattering, about 20.

It was moved that the ballots be closed and that the Secretary be instructed to cast the ballot of the Club for Messrs. Pratt, Olmstead and Park for directors.

The President: It has been moved and seconded that the Secretary be instructed to cast the ballot for Messrs. Pratt, Olmstead and Park for directors. Those in favor please say "aye." Contrary "no." Carried.

The Secretary: Mr. President, I have done so with pleasure.

The Secretary: I move that the thanks of the Club be extended to the counting and collecting tellers for their arduous services this evening.

The President: You have heard the motion. All in favor say "aye." It is carried.

The President: Our newly elected President, Mr. Goodnow, is very modest, and I will have to appoint some one to assist him to the chair. Mr. Hennessey, will you kindly escort the newly elected president to the chair?

Mr. J. J. Hennessey: Members of the Western Railway Club—It gives me pleasure to introduce to you your newly elected president. He is a young man whom I have known for a number of years, and I feel that he is one of the comers. Your new President. (Applause.)

Mr. Young: I want to congratulate this Club on having elected so good a man to preside over it the coming year.

President Goodnow: Members of the Western Railway Club—Your retiring president is trying to put one over you; he did not make his retiring speech. As far as the incoming president is concerned, he is not going to take much time, because there has been a very able entertainment committee appointed, and they are getting restless back here; we cannot hold them in. I simply want to thank you for the honor bestowed upon me this evening and at this time take the opportunity of making this one plea for the ensuing year. The Secretary said we had had an average attendance this year. That is a fact, but we want to beat that this coming year and we can only do that by having a turn-out, and the Club, or the officers and the Board of Directors, earnestly invite that, and at the same time, suggestions on papers. If we can have good papers we will have an attendance, and we earnestly hope that each one of you will constitute yourselves a committee of one to help us out in that. I thank you again for the honor conferred upon me.

Mr. Hennessey: Mr. President, is it in order to make a motion to reconsider some of the action of the meeting here tonight? If it is, I move that we reconsider the vote of election of Secretary-Treasurer, and that it is the sense of this meeting that the three scattering votes be considered Secretary and Treasurer. (Laughter.)

On motion of a member the unanimous thanks of the Club were extended to the retiring officers.

Adjourned

After the business session the members were entertained by talent from its own membership, the following program having been arranged:

ANNUAL ENTERTAINMENT

THE CHARACTERS.

1. OXFORD QUARTETTE.......................................STEIN SONG

They claim to have four finely blended voices, and they are all soloists. Listen to them.

2. THE WIZARD HUDSON.......................................PIANOLOGUEIST

The Wizard wished to present the latest, and therefore could not name selection.

3. MR. ARTHUR SCOTT.......................................TENOR SOLO

Arthur always has some good ones. You will not be disappointed.

4. MR. J. WILL JOHNSON.......................................CORNETTIST

Represents the Pyle National Electric Headlight Co. during the day and blows himself red in the face on the cornet at night.

5. MR. FRED. S. HICKEY.......................................COMIC SONGS

Mr. Hickey's specialty is the Dearborn Drug & Chemical Works. When the drugs and chemicals won't work his songs will.

6. MR. FRANK RYAN.......................................STORIES

Mr. Ryan made such a hit last year that his engagement was immediately procured for this occasion. He sells springs for the Pittsburgh Spring & Steel Co.

7. MR. W. L. RIEDELL.......................................BASS SOLO

This gentleman represents Crerar, Adams & Co. in business and the Oxford Quartette in music.

8. MR. GUS VOSS.......................................PIANOLOGUE

Mr. Voss is a special friend of the President, but he don't work for the Burlington Road.

9. DR. C. B. ROE.......................................TENOR SOLO

A dentist by trade; a musician by profession, or may be it's the other way.

10. MR. JACK PONIC.......................................A FEW STUNTS

He represents J. B. Clow & Sons. What he will introduce will be the zero of entertainment.

11. THE GERMAN BAND...............HERR JOHANN PONIC, BANDMEISTER

First and only appearance in this country—Special permission of the Kaiser.

PRESS COMMENTS

Herald—Greatest entertainment ever pulled off in a club. But that is expected of the Western Railway Club. All the stunts were good, and the music, especially the Oxford Quartette, of high class.

News—The classiest of entertainers. Splendid program. The Wizard Hudson belongs to Wall street.

Journal—A fine male vaudeville. Everything in that line for an evening's entertainment. Musical selections unusually classy. No one disappointed.

Post—Nothing lacking in this entertainment, even to the cornettist. Program of unusually high class and well rendered.

Trib—If we were to specialize, Hickey's stunts led. Club to be congratulated on having such talent in its membership.

Amer—Congregation in spasms of laughter from start to finish. Ryan such a story teller (?); he was almost believeable. Finest program ever.

Gazette—Didn't believe the club had such talent. Every act up-to-date. Musical parts best ever heard in Chicago. Riedell was at his best.

Review—The Western Railway Club is a live one. Never suspected such artistic temperament in its membership. The President's friend made the hit of the evening. He should be a bank president.

Mechanic—Prouder than ever of the Club. For a bunch of mechanicians they certainly have diversified talents. Hope a similar program can be arranged for an early date.

Abend—What was designated as the zero of entertainment proved to be of the highest order. Herr Ponic displayed unusual leadership as a bandmeister. His ability to produce such beautiful tonal effects was marked. Nothing but the proudest enconiums should be awarded his band of players. They were gentleman of true Teutonic origin and thoroughly steeped in the music of the Fatherland. We extend our congratulations to the Kaiser and let it go at that.

CONSTITUTION

ARTICLE I.

The name of this association shall be the Western Railway Club.

ARTICLE II.

Objects.

The objects of this association shall be the advancement of knowledge relating to safe and economical railway operation, and to the construction, maintenance and service of railway machinery, motive power and rolling stock, by discussion in common, investigation and reports of the experience of its members; to provide an organization through which the members may help to bring about uniformity and interchangeability of the parts of railway cars, to improve their construction, and to adjust the mutual interests growing out of their interchange and repair.

ARTICLE III.

Membership.

This club shall consist of persons interested in railroad matters generally, who may be admitted by a majority of quorum vote of the executive committee and the payment of the annual assessment, and who shall receive copies of the proceedings issued in the current year prior to the date of admission to the club, provided the secretary has sufficient additional copies for this purpose.

ARTICLE IV.

Officers.

The officers of this club shall hold office for one year, to be elected at the annual meeting, and shall consist of:

1. A president, who shall preside at all meetings of the club and perform the duties pertaining to a presiding officer. He shall also be a member and chairman of the executive committee, shall approve of all bills before payment, and shall countersign all checks drawn by the treasurer on the funds of the club, said checks not being negotiable without his signature.
2. A vice-president, who shall, in the absence of the president, perform all duties required of that office.
3. A second vice-president, who shall, in the absence of both the president and vice-president, perform the duties of the office of president.
4. A secretary, who shall also be the secretary of the executive committee and a member of that committee. The secretary shall be appointed by the executive committee, and shall keep the minutes of all meetings, have charge of the publication of the club proceedings, and perform other routine work pertaining to the business affairs of the club, under the direction of the executive committee.
5. A treasurer, who shall have charge of all funds, and pay all bills when audited by the executive committee and approved by the president, and who shall submit at each regular meeting of the executive committee an exact statement of his accounts and the condition of the funds of the club, and shall make an annual report to the club at the end of the year, and such reports during the year of the condition of the funds of the club as may be required.

6. The executive committee shall consist of six members, including the officers of the club and a sixth member of the committee, who shall be elected by the club. The executive committee shall arrange programmes for meetings and have general supervision over the interests of the club, and shall audit all bills before payment and audit the books of the secretary and treasurer at each regular meeting.

Election.

7. Election shall be had by informal written ballot for nominations, to be followed by a formal written ballot for election. Only the two candidates receiving the highest number of votes in the informal ballot shall be voted upon in the formal ballot.

ARTICLE V.

Amendments.

This constitution may be amended at any regular meeting of the club by a three-fourths vote of the members present and voting, said amendment having been proposed in writing at a previous regular meeting.

ARTICLE VI.

Discussion by Patentees.

No patentees or their agents, or agents for the sale of railway supplies shall occupy the attention of the meeting in the interests of devices in which they are personally or financially interested, unless they are especially invited to do so by a majority of the members present, or by consent of a majority of the executive committee, and then only when the article they represent forms a part of the subject for discussion at the regular meeting.

ARTICLE I.

Section 1. Meetings of the club shall be held on the third Tuesday of each month at 2 p. m., except in the months of June, July and August.

Sec. 2. The annual meeting shall be held on the third Tuesday in May of each year.

Sec. 3. The president, or a majority of the executive committee, may call special meetings at such times as he or they may deem expedient.

ARTICLE II.

At any regular meeting, five members shall constitute a quorum.

ARTICLE III.

The order of business shall be as follows:

1. Approval of minutes.
2. Announcement of new members and reception of applications for membership.
3. Unfinished business.
4. Reports of committees.
5. New business.
6. Discussion of paper read at previous meeting.
7. Recess.
8. Presentation of paper or report.
9. Appointment of committees.
10. Election of officers.
11. Announcement of subject for next meeting.
12. Adjournment.

ARTICLE IV.

Any person eligible under the constitution, and having been elected by the executive committee, becomes a member of the association by paying the annual dues. All members, whether railway employes or railway supply agents, shall have equal rights in all discussions, and in all business which properly comes before the meetings of the club, except as provided in Article VI of the Constitution.

ARTICLE V.

At the annual meeting, the names of those members whose assessments are unpaid for the year then ended, may be dropped from membership, and such persons shall not be eligible to further membership until all back dues are paid.

ARTICLE VI.

The executive committee is expected to provide papers or matter for discussion at each regular meeting; to have the same in print for distribution at the meeting, and to arrange for prompt publication of the proceedings.

ARTICLE VII.

The secretary will mail the printed proceedings to all members of this and other exchanging railroad clubs, and to the technical and other papers, not later than the second Saturday after the Tuesday of the meeting. The technical papers are requested not to make reports of the proceedings of the meeting, or of papers read before the club, except as presented in the printed proceedings.

ARTICLE VIII.

The stenographic report of the meeting will be confined to resolutions, motions, and discussions of papers, and all miscellaneous discussion of the affairs of the club or general business will not be reported by stenographer unless specially so instructed by the presiding officer, or by adopted motion of a member.

ARTICLE IX.

These by-laws may be amended at any regular meeting of the club by a vote of three-fourths of the members present and voting; such amendment having been proposed in writing at a previous regular meeting.

THE DAVID L. BARNES LIBRARY

SPECIAL NOTICE.

The David L. Barnes Library of this Club, at 390 Old Colony Bldg., Chicago, is open for the use of members and their friends, and we hope it will be used freely. It is open on week days from 9 a. m. to 5:30 p. m., except on Saturday, until 3 p. m. Books must not be removed from Library, but the Librarian will assist visitors in finding information and will promptly reply to letters from out-of-town members desiring information from the Library. Donations of books and technical publications will be gratefully received.

TRUSTEES OF THE LIBRARY.

In Memoriam

W. F. Buck

J. F. Mann

M. E. Ward

W. W. Johnson

M. J. Horan

Joseph McDonald

C. E. Olhausen

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WESTERN RAILWAY CLUB

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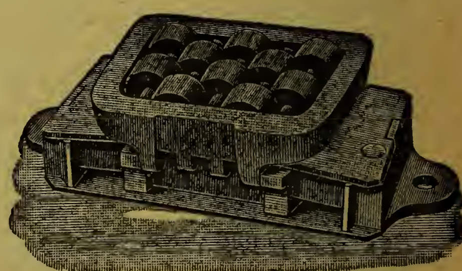
ELECTION OF OFFICERS

ANNUAL ENTERTAINMENT



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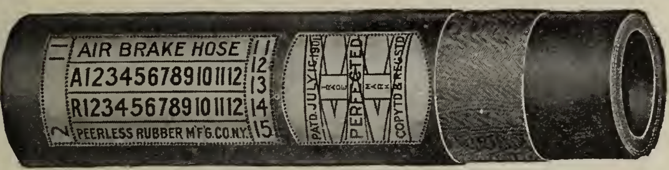

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